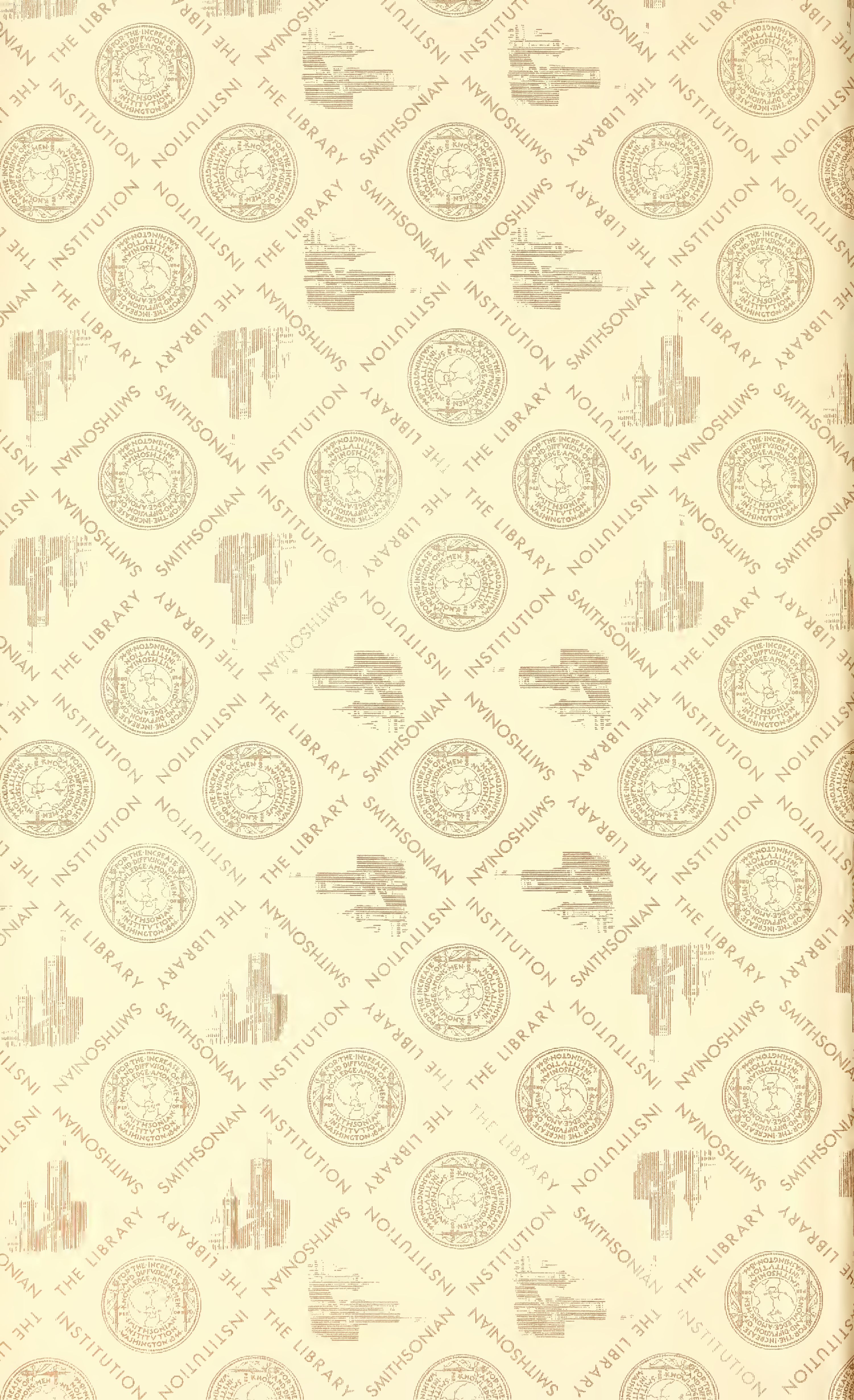
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New Termitophilous Staphylinidae (Coleoptera) from Hodotermitidae (Isoptera) Nests[1]

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Received for Publication July 28, 1969

Abstract: The subtribe Termitotelina is revised and the single included genus, *Termitotelus*, is redescribed and illustrated. The 1 previously described species is redescribed and the following 4 new species are described: *T.* **sheasbyi**, *T.* **coatoni**, *T.* **niger**, and *T.* **neoschultzei**, all from Cape Province, Republic of South Africa. A new subtribe, Hodoxenina, is proposed to contain a new genus, **Hodoxenus**, which is described. The single included species, *H.* **sheasbyi**, from Cape Province is described as new. All species are found with *Microhodotermes viator*. A summary of previously collected species from Hodotermitidae nests is presented.

INTRODUCTION AND TAXONOMIC HISTORY

It has been over 60 years since Wasmann (1908) wrote his review paper on the termitophiles associated with the Hodotermitidae and described the staphylinid, *Termitotelus schultzei*, from a nest of *Microhodotermes viator* (Latreille). Since then, no other species of Staphylinidae have been recorded with the Hodotermitidae, and I do not believe any other insects have been recorded either.

Table 1 presents a summary of the previously known termitophiles from Hodotermitid nests derived from Wasmann's (1908) paper. Most of the species in Table 1 lack host specificity and probably are not termitophiles in the traditional sense which implies a sort of symbiotic relationship (see Kistner's, 1969, paper for a fuller explanation). Brauns (in Wasmann, 1908) captured all 3

Acknowledgments: I wish to thank W. G. H. Coaton, Plant Protection Research Institute, Pretoria (N.C.I.), for making the specimens available for study as well as determining the host termites. Thanks are also given to J. K. A. Van Boven for courtesies extended to me while study the Wasmann collection in Maastricht (N.H.M.). Thanks are given to A. E. Emerson for reading this manuscript and making suggestions for its improvement.

I wish to thank particularly David Harwood, Lynette Hawver, Herbert Jacobson, Lynn Royce and Virginia Sleppy, all Shinner Assistants of Chico State College, for technical assistance rendered in connection with this study.

The initials given above will be used to designate the deposition of the specimens cited in the text. Specimens retained in the collection of the author are indicated (DK).

[1] This study was supported in part by the National Science Foundation (Grant No. GB-12668). The type studied was done while a Fellow of the John Simon Guggenheim Foundation, New York, and while on a sabbatical leave from Chico State College.

New York Entomological Society, LXXVIII: 2–16. March, 1970.

Table 1. Summary of termitophiles known from the nests of Hodotermitidae, after Wasmann (1908).

Termitophile	Host
Collembola	
Cyphoderus colurus Börner	*Microhodotermes viator* (Latreille)
Coleoptera	
Histeridae	
Monoplius pinguis Lewis	*M. viator*, *Hodotermes mossambicus* (Hagen)
M. inflatus Marseul	*M. viator*, *H. mossambicus*
M. peringueyi Brauns	*M. viator*, *H. mossambicus*
Cetonidae	
Elpidus hopei Burmeister	*M. viator*, *H. mossambicus*
Xiphoscelis gariepina G. and P.	*M. viator*, *H. mossambicus*
Scarabaeidae	
Pynoschema corydon Oliver	*H. mossambicus*
Syrichthus verus Burmeister	*H. mossambicus* *Trinervitermes trinervoides* (Sjoestedt)
Trichoplus aepytus Kolbe	*M. viator*
T. agis Kolbe	*M. viator*
Staphylinidae	
Termitotelus schultzei Wasmann	*M. viator*
Isopoda	
Phylloniscus braunsi Purcell	*M. viator*, *H. mossambicus*

species of the histerids in nest piles (soil dumps of Coaton, 1958) of both termite species and stated that both the larvae and the adults are termite predators and do not live off of nest wastes or termite excreta as previous workers had thought. Similarly the scarabaeids, *Pycnoschema* sp. and *Syrichthus* sp., were captured in the soil dumps and not in the nests themselves. Other scarabaeids have been captured in loose association with *Zootermopsis* sp. in the United States.

Probably the only true termitophiles listed are the scarabaeids, *Trichoplus*, that are related to *Cremastocheilus* and the staphylinid, *Termitotelus*. The *Phylloniscus*, which is not host specific, may simply be a detritus eater as has been claimed for other Oniscidae such as *Trichorina hospes* Silvestri which is associated with *Fulleritermes tenebricus* (Silvestri). If the habits of *Trichoplus* are similar to those reported for *Cremastocheilus* by Cazier and Mortenson (1965), then we can expect *Trichoplus* to be predaceous upon their termite hosts. It would be difficult to imagine that *Termitotelus* was anything other than a predator. The *Trichoplus* and the *Termitotelus* were collected from the same original termite nest by L. Schultze.

Wasmann also reported the presence of *Angulitermes braunsi* (Wasmann) from the nests of both *M. viator* and *H. mossambicus*. Wasmann stated that it appears that this termite species regularly lives with the two termites.

In 1963 and again in 1968, Mr. J. L. Sheasby, excavated *Microhodotermes viator* nests and collected many new species of Staphylinidae. It is the purpose of this paper to report the new species and the new genus of Staphylinidae he collected. Seevers (1957) placed the genus *Termitotelus* in its own subtribe which he stated was closely related to the Athetini. I concur with this arrangement and present here additional characters wihch help to differentiate this subtribe from the rest of the subtribes of the Athetini. The new genus also represents a new subtribe of the tribe Aleocharini. Previous to this year, there were no Aleocharini-related termitophiles. This is the third new subtribe that I have described this year. None of the three subtribes are directly related to each other and each represents a separate invasion of diverse groups of termites.

Microhodotermes presently has two separate groups of staphylinid termitophiles which represent separate invasions of the termite nests. It will be interesting to see if the palearctic species has related termitophiles.

The methods used for the study of these insects have been given previously by Kistner (1968). All measurements cited in this study are given in mm unless otherwise indicated. All specimens cited in this study have as their host, *Microhodotermes viator* (Latreille) as determined by W. G. H. Coaton.

Subtribe Termitotelina Seevers

Termitotelina Seevers 1957: 250.

Seevers (1957) proposed this subtribe to contain the single genus *Termitotelus* which at that time had only been recorded once from a termite nest in South-West Africa. The recapture of this genus and the description of new species gives us some new insight into the characters that separate this subtribe from the other subtribes of the Athetini.

The following characters serve to separate this tribe from the rest of the Athetini: The shape of the highly modified abdominal segment IX. The elongate shape of the mandibles. The shape of the labrum. The presence of hyaline spots on most of the sclerotized parts of this beetle. These spots can be seen in the figures of the elytra, the labrum, and the enlargement of the terminal segment of the antennae (Fig. 3).

The tribe still contains but a single genus which is redescribed below.

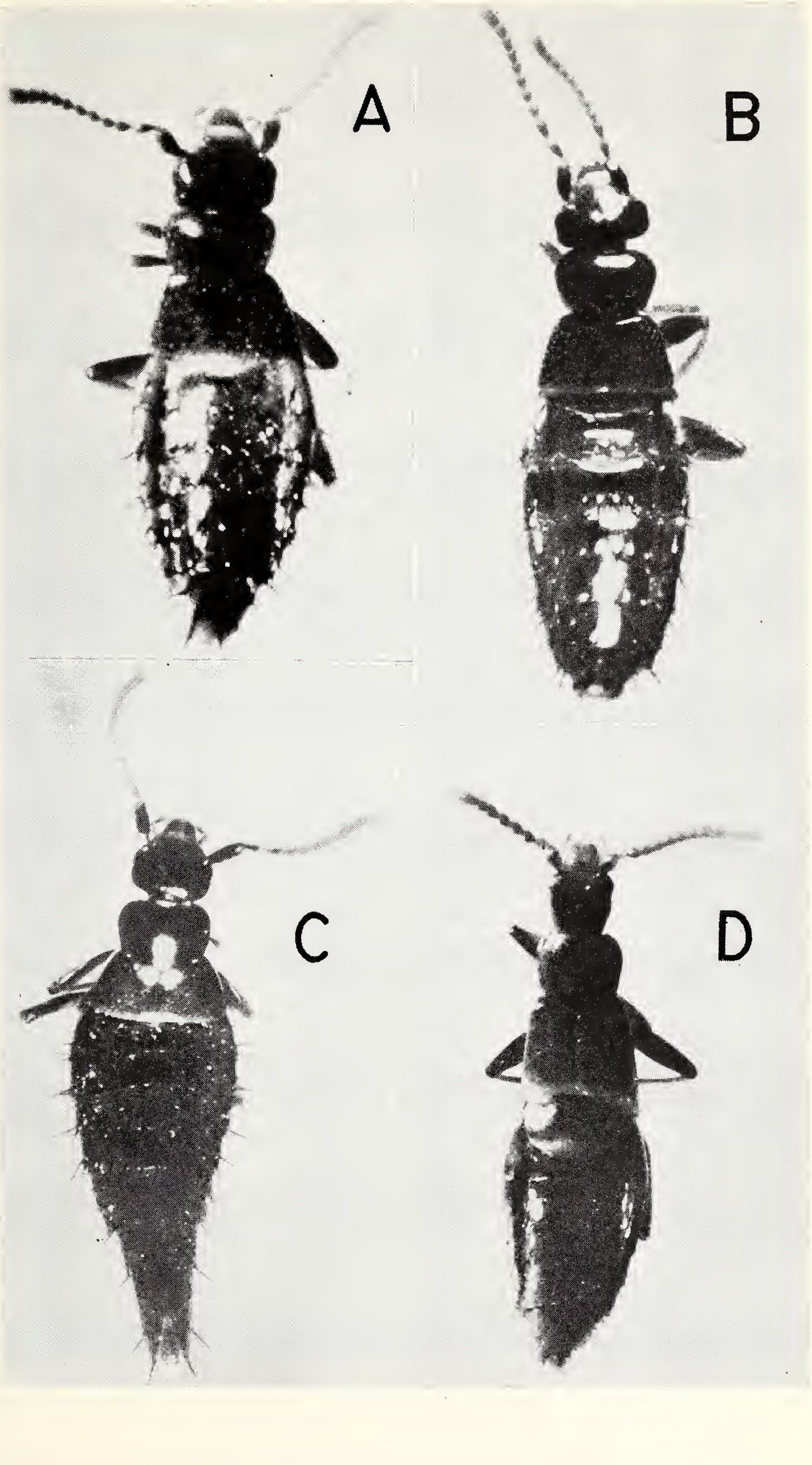
Termitotelus Wasmann

Termitotelus Wasmann 1908: 444; Seevers 1957: 250; Kistner 1969: 530.

Most closely related to *Atheta* (s. lat.) from which it is distinguished by many characters. A partial list of these consists of the peculiarly shaped labrum, the hind coxae which are semitriangular in shape and broadly expanded dorsoventrally, as well as the presence of hyaline areas over all surfaces of the body and including the legs and the antennae.

→

Fig. 1. Dorsal view of entire beetle: A, *Termitotelus* **neoschultzei**; B, *T.* **niger**; C, *T.* **coatoni**; D, **Hodoxenus sheasbyi**. Scale arbitrary, see description for measurements.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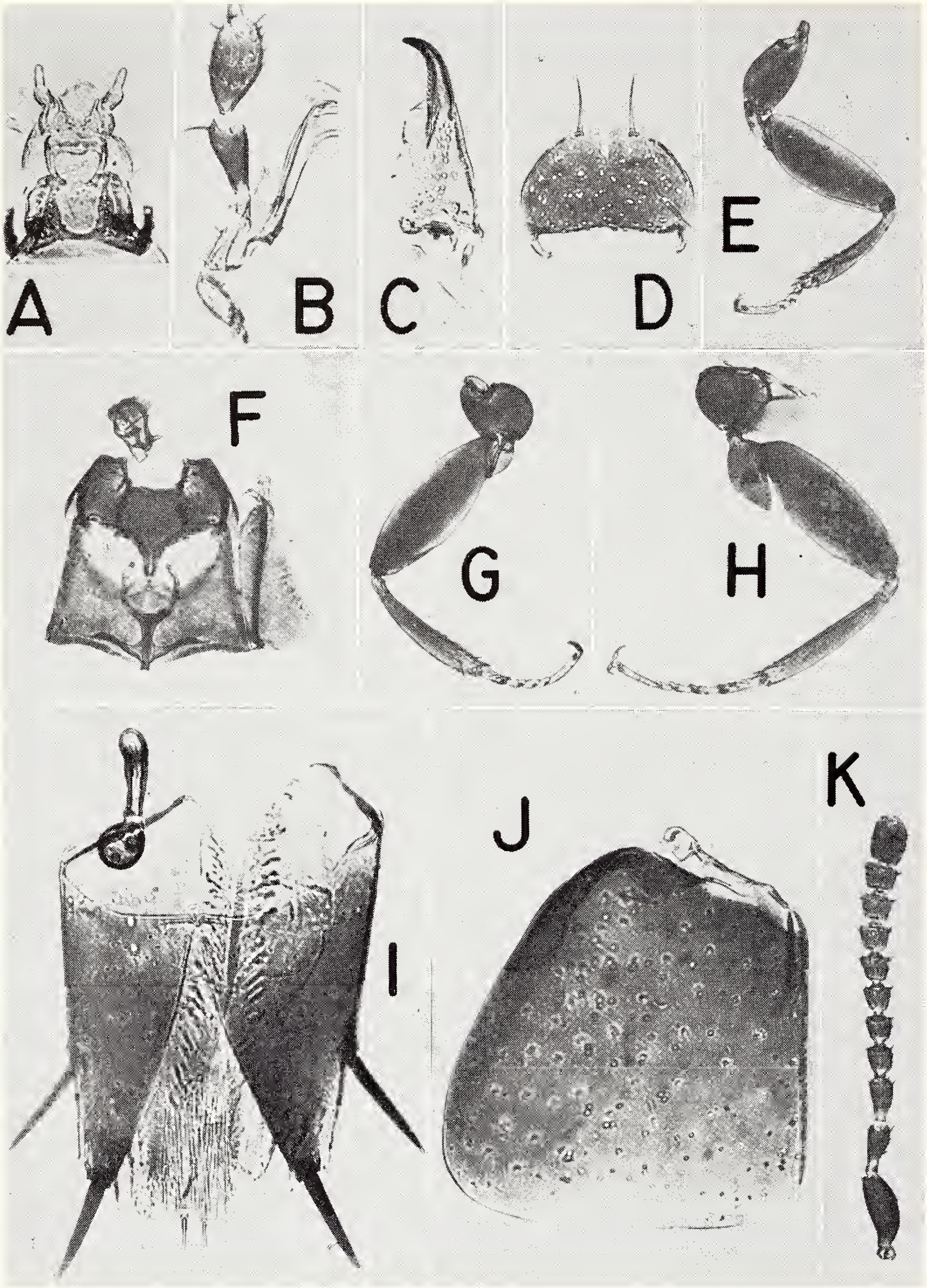

FIG. 2. *Termitotelus* **neoschultzei**: A, Labium and mentum; B, Maxilla; C, Left mandible; D, Labrum; E, Proleg; F, Meso- and metasternum; G, Mesoleg; H, Metaleg; I, Abdominal segment IX of female with spermatheca; J, Elytron; K, Antenna. Scale arbitrary, see description for measurements.

Overall shape as in Figs. 1A, B, and C. Head capsule slightly wider than long with a distinctly developed neck posteriorly and with a nuchal ridge. Antennae inserted between the eyes very close to the anterior border of the eyes and very near to the anterior tentorial pits. Eyes large and well-developed with most facets directed laterally. Eyes rounded but with a

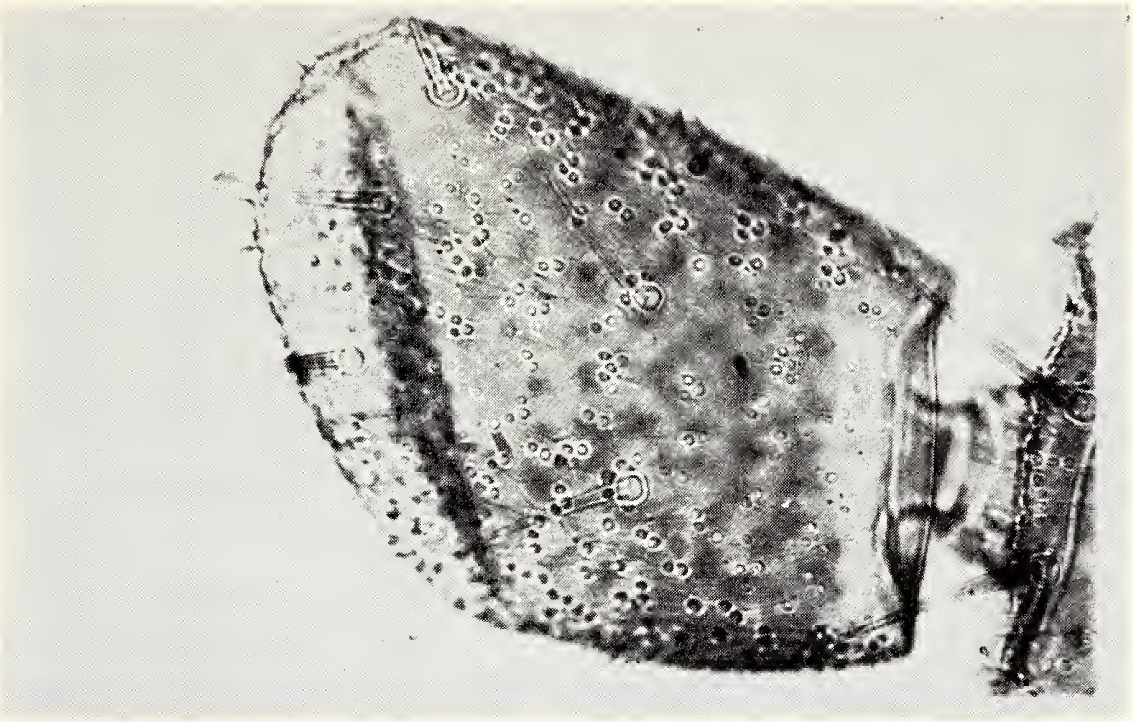

Fig. 3. *Termitotelus* **coatoni**, enlarged apical segment of antennae showing numerous hyaline areas over the surface. Scale arbitrary, see description for measurements.

relatively straight posterior border. Gula with rounded lateral borders such that they bow out in the middle and are about the same distance apart both at the anterior and posterior ends. Submentum fused to the gula. Mentum distinct but much shorter than the submentum. Submentum about half the length of the gula. Mandibles symmetrical, shaped as in Fig. 2C. Note the large number of very small teeth on the inner surface of the mandible. Maxillae shaped as in Fig. 2B; palpi 4-segmented. Maxillary acetabulae not margined. Labium shaped as in Fig. 2A; palpi 3-segmented. Labrum highly distinctive, shaped as in Fig. 2D.

Pronotum slightly wider than long; shaped as in Fig. 1A-C, slightly variable by species. Hypomera reflexed only slightly ventrally to about ¼ or ⅕ the width of the pronotum. Prosternum normal in shape with short anterolateral articulation processes, rounded between the legs but with a carina running laterally in about the middle. Prothoracic coxal cavities closed behind by membrane with only a vestige of the mesothoracic peritremes in the membrane. Elytra without distinction, shaped as in Fig. 2J; lateral edges not reflexed ventrally to any great extent. Wings present, of normal size, with the usual staphylinid venation. Mesosternum about the same length as the metasternum if the length of the intercoxal process is counted, shaped as in Fig. 2F. Mesosternal intercoxal process acute, acarinate, and thin. Mesocoxal acetabulae margined. Pro-, meso-, and metalegs shaped as in Figs. 2E, 2G, and 2H respectively; tarsal formula 4-5-5.

Abdomen shaped as in Figs. 1A-C, not physogastric. Segment I represented only by the tergite fused to the metanotum. Segment II represented only by a tergite. Segments III-VII with 1 tergite, 1 sternite, and 2 pairs of paratergites each. Segment VIII represented by a tergite and sternite only. Dorsal margin of the abdomen occurs between the inner and outer paratergites. Tergal gland opening on anterior border of tergite VI reduced in size and median in position. Segment IX trilobed, shaped as in Fig. 2I, anterior apodemes of male not very conspicuous. Female spermatheca sclerotized, variable by species. Median lobe of male genitalia bulbous, variable by species. Lateral lobe of male genitalia nearly constant for all species, shaped as in Fig. 4D. Entire surface of beetle with many hyaline areas containing punctures, particularly noticeable on the elytra (Fig. 2) and the antenna (Fig. 3).

Type species: *Termitotelus schultzei* Wasmann

KEY TO SPECIES

1. Surface of head, pronotum, and elytra shagreened .... *T. schultzei*
1′ Dorsal surface of head, pronotum, elytra and abdomen smooth and shiny 2
2. First segment of antenna as long as or longer than the head; pronotum somewhat heart-shaped .... *T.* **sheasbyi**, n. sp.
2′ First segment of antenna shorter than head; pronotum broad, shaped as in Fig. 1A 3
3. Abdominal tergites IV, V, VI with 8 macrochaetae on each .... *T.* **coatoni**, n. sp.
3′ Abdominal tergites IV, V, VI with 6 macrochaetae on each 4
4. Abdominal sternites IV-VIII with both apical and anteapical rows of short stout macrochaetae .... *T.* **niger**, n. sp.
4′ Only sternite VII with an anteapical row of but 2 macrosetae; all other sternites with only an apical row on each .... *T.* **neoschultzei**, n. sp.

Termitotelus schultzei Wasmann

Termitotelus schultzei Wasmann 1908: 444, pl. 22A, Fig. 7, 7A, 7B-Naturhistorisch Museum, Maastricht, [South-West Africa, Klein Namaland, Kookfontein, with *Microhodotermes viator*]; Seevers 1957: 250.

Most closely related to *T.* **neoschultzei** from which it is distinguished by the surface sculpture.

Color very dark reddish-brown throughout, approaching black. Dorsal surface of the head, pronotum, elytra, and abdomen shagreened, not shiny. Head with 9 to 10 long yellow setae at each posterior corner. Pronotum and elytra devoid of all but the tiniest very short yellow setae which are randomly and sparsely scattered about. Macrochaetotaxy of abdominal tergites II-VIII as follows: 2,4,6,6,6,4,2-4. Sternite III with an apical sparse row of setae, lateral setae longer than the median setae. Sternites IV-VIII with an apical and anteapical row of stout setae, anteapical row somewhat shorter than apical row. Outer paratergites with 2 macrosetae each. Male genitalia and female spermatheca unknown.

Measurements: Head length, 0.28; pronotum length, 0.30; elytra length, 0.28. Number measured, 1.

Material examined: Type and co-type, (NHM).

Notes: The rough sculpture I thought at first might be due to the accumulation of dust and grime on the type series. However, Wasmann (1908) definitely states that the surface is not shiny, so that is interpreted here to mean that the surface always looked very similar to the way it looks now. It is believed that when more specimens are available from the type locality, other characteristics will emerge to differentiate this species from the rest. In the meantime, there is sufficient endemism in this genus that I do not believe that any of the other species are likely to be confused with this one.

Termitotelus **coatoni**, n. sp.

Figs. 1C; 3; 4A, B, D

Most closely related to *T.* **sheasbyi** from which it is distinguished by the abdominal macrochaetotaxy as well as the shape of the pronotum and the shape of the male genitalia.

Color dark reddish-brown throughout, approaching black. Dorsal surface of the head, pronotum, elytra, and abdomen except for the setae, shining with hyaline spots scattered evenly about. Dorsal surface of the head with 9 long yellow setae at each posterior corner. Pronotum and elytra devoid of all but the tiniest short setae which are randomly and sparsely scattered about. Macrochaetotaxy of abdominal tergites II-VIII as follows: 2,4,8,8,8,6,2-4. Sternites all with an apical row of stout setae which are longest near the lateral border. Sternites V-VIII with an anteapical row on each. Outer paratergites with 2 macrosetae each. Median lobe of male genitalia shaped as in Fig. 4A. Female spermatheca shaped as in Fig. 4B. Measurements: Head length, 0.25–0.27; pronotum length, 0.25–0.31; elytra length, 0.25–0.30. Number measured, 10.

Holotype: 1, No. 12525, Republic of South Africa, Cape Province, 16 mi ex Klaarstroom-Prince Albert, 15 October 1963, Coll. J. L. Sheasby, No. T-193. In the National Collection of Insects, Pretoria.

Paratypes: Republic of South Africa, Cape Province: 23, same data as holotype, (NCI, DK); 1, 30 mi ex Calvinia-Loriesfontein, 25 April 1968, Coll. J. L. Sheasby, No. T-668, (NCI); 1, 10 mi ex Calvinia-Ceres, 30 April 1968, Coll. J. L. Sheasby, No. T-680, (NCI); 1, at Nieuwoudtville, 2 May 1968, Coll. J. L. Sheasby, No. T-689, (NCI).

Notes: Specimens of the hosts are in the National Isoptera Collection, Pretoria, under accession numbers TM 12600, TM 23030, TM 23074, and TM 23083. The species is named for W. G. H. Coaton who supplied these and many other specimens of South African termitophiles for study.

Termitotelus **neoschultzei**, n. sp.

Figs. 1A; 2; 4E, F

Most closely related to *T.* **schultzei** and *T.* **niger** from which it is distinguished by the abdominal macrochaetotaxy, the surface sculpture, as well as the shape of the male genitalia and the shape of the spermatheca.

Color dark reddish-brown throughout, approaching black. Dorsal surface of the head, pronotum, and elytra smooth and shiny with hyaline spots scattered evenly over the entire surface. Head with about 7 to 9 longer yellow setae at each posterior corner. Pronotum and elytra without any conspicuous chaetotaxy but with a series of very small fine setae scattered sparsely but evenly about. Macrochaetotaxy of abdominal tergites II-VIII as follows: 2,4,6,6,6,4,2-2. Abdominal sternites III-VI with an apical row of stout setae on each only. An anteapical row of 2 setae is present on sternite VII. Sternite VIII has a series of short stout setae scattered over the surface. Outer paratergites with 2 macrosetae each. Median lobe of male genitalia shaped as in Fig. 4F. Female spermatheca shaped as in Fig. 4E. Measurements: Head length, 0.22–0.27; pronotum length, 0.21–0.25; elytra length, 0.19–0.26. Number measured, 10.

Holotype: 1, No. 13619, Republic of South Africa, Cape Province, 20 mi ex Loriesfontein-Nieuwoudtville, 28 April 1968, Coll. J. L. Sheasby, No. T-678. In the National Collection of Insects, Pretoria.

Paratypes: Republic of South Africa, Cape Province: 5, same data as holotype, (NCI, DK); 4, 20 mi ex Loriesfontein-Nieuwoudtville, 26 April 1968, Coll. J. L. Sheasby, No. T-672, (NCI, DK); 2, same locality as previous, 26 April 1968, Coll. J. L. Sheasby, No. T-674, (NCI, DK); 3, same locality as previous, 28 April 1968, Coll. J. L. Sheasby, No. T-676, (NCI, DK); 2, at Nieuwoudtville, 1 May 1968, Coll. J. L. Sheasby, No. T-684, (NCI, DK); 2, at Nieuwoudtville, 2 May 1968, Coll. J. L. Sheasby, No. T-689, (NCI, DK).

Notes: The host specimens are found in the National Isoptera Collection, Pretoria, under accession numbers TM 23049, TM 23045, TM 23048, TM 23080, and TM 23083. So far as I can tell this species is the closest to *T. schultzei* Wasmann and hence is given the name **neoschultzei**.

Termitotelus **niger**, n. sp.

Figs. 1B; 4C, G

Most closely related to *T.* **neoschultzei** from which it is distinguished by the shape of the spermatheca and the male genitalia as well as the chaetotaxy of the abdomen.

Color dark reddish-brown throughout, approaching black. Dorsal surface of the head, pronotum, elytra, and abdomen smooth and shiny, with many hyaline spots scattered evenly over the surface. Dorsal surface of head with 7 to 9 longer setae at each posterior corner. Dorsal surface of pronotum and elytra with only a very sparse but even covering of fine setae which are scarcely visible. Macrochaetotaxy of abdominal tergites II-VIII as follows: 2,4,6,6,6,4,2-4. Sternite III with an apical sparse row of setae of which only the lateral ones are large. Sternites IV-VIII with both an apical and an anteapical row of stout setae of which the anteapical row is somewhat shorter than the apical row. Outer paratergites with 1 seta each. Male genitalia shaped as in Fig. 4G. Female spermatheca shaped as in Fig. 4C. Measurements: Head length, 0.19–0.30; pronotum length, 0.20–0.31; elytra length, 0.20–0.34. Number measured, 7.

Holotype: 1, No. 13629, Republic of South Africa, Cape Province, 10 mi ex Klaarstroom-Prince Albert, 15 October 1963, Coll. J. L. Sheasby, No. T-193. In the National Collection of Insects, Pretoria.
Paratypes: 6, same data as holotype, (NCI, DK).

Notes: The host termites are in the National Isoptera Collection, Pretoria, under accession number TM 12600.

Termitotelus **sheasbyi**, n. sp.

Fig. 4H

Most closely related to *T.* **coatoni** from which it is distinguished by the shape of the male genitalia, the macrochaetotaxy, and the shape of the pronotum.

Antennae longer than in the rest of the species, 1st segment as long as or longer than the head. Color dark reddish-brown throughout, approaching black. Dorsal surface of the head, pronotum, elytra, and the abdomen smooth and shiny with hyaline spots scattered evenly about. Dorsal surface of head with a row of coarse setae at the lateral margin. Pronotum

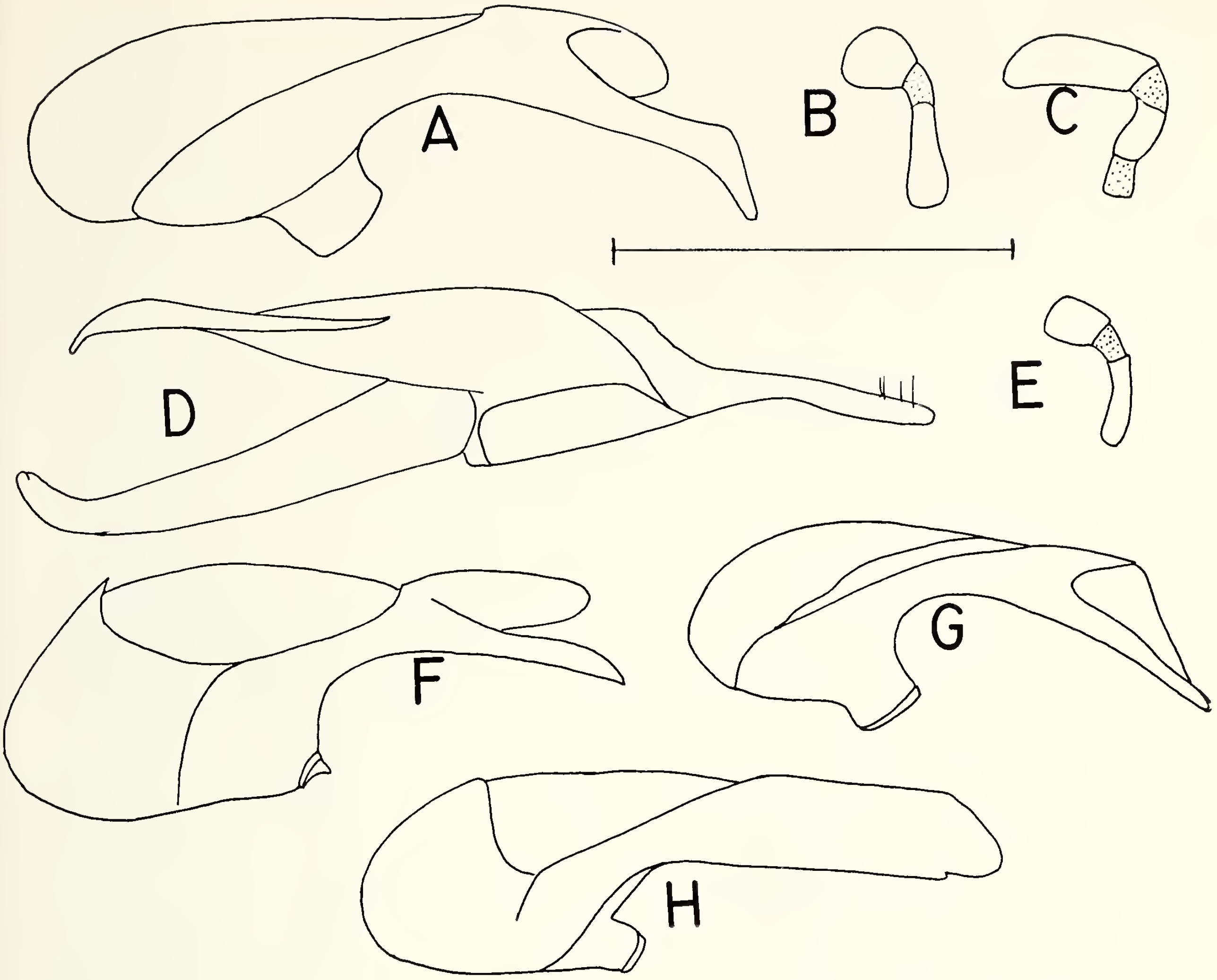

Fig. 4. Median lobes of male genitalia: A, *Termitotelus* **coatoni**; F, *T.* **neoschultzei**; G, *T.* **niger**; H, *T.* **sheasbyi**. Lateral lobe of male genitalia; D, *T.* **coatoni**. Spermathecae: B, *T.* **coatoni**; C, *T.* **niger**; E, *T.* **neoschultzei**. Scale represents 0.25 mm and applies to all figures.

with 1 seta each at the anterior corners. Elytra with 2 setae at each anterior corner, 2 on each lateral margin, 3 on the disk of which 1 is very close to the lateral margin. Macrochaetotaxy of abdominal tergites II-VIII as follows: 2,6,8,8,4-8,4-2-4, segment VIII with a lateral row of 4 on each side plus 2 more at the posterior border. Sternites with macrosetae all over them. The rows are so numerous that they break down. Male genitalia shaped as in Fig. 4H. Female spermatheca unknown.
Measurements: Head length, 0.30–0.32; pronotum length, 0.29–0.31; elytra length, 0.24–0.26. Number measured, 3.

Holotype: 1, No. 13628, Republic of South Africa, Cape Province, 20 mi ex Loriesfontein-Nieuwoudtville, 26 April 1968, Coll. J. L. Sheasby, No. T-669. In the National Collection of Insects, Pretoria.
Paratypes: 1, same locality as holotype, 26 April 1968, Coll. J. L. Sheasby, No. T-674, (NCI); 1, same locality as holotype, 28 April 1968, Coll. J. L. Sheasby, No. T-676, (DK).

Notes: The host termites are in the National Isoptera Collection, Pretoria, under accession numbers TM 23040, TM 23045, and TM 23048. The species is named for Mr. J. L. Sheasby who collected the specimens.

Subtribe Hodoxenina, new subtribe

The following characters serve to distinguish this subtribe from the rest of the subtribes of the tribe Aleocharini: The overall appearance including the narrow long head. The enlarged second tergite of the abdomen. The shape of the highly modified abdominal segment IX. The presence of 5-segmented maxillary palpi and 4-segmented labial palpi clearly relate this subtribe to the tribe Aleocharini.

The subtribe presently contains but one genus which is described below.

Genus **Hodoxenus**, n. gen.

A highly unique genus which is most closely related to the genus *Aleochara* Gravenhorst from which it is easily distinguished by the overall shape as well as the extremely large second abdominal tergite and the shape of abdominal segment IX.

Overall shape as in Fig. 1D. Head capsule longer than wide, without a distinct neck. Head capsule trapezoidal in form, shaped as in Fig. 1D. Eyes present, round in outline from the side, with many laterally and anteriorly directed facets. Antennae inserted between the eyes very near to the anterior tentorial pits. Antennae 11-segmented, shaped as in Fig. 5F. Gula long with the sides slightly divergent toward the posterior but curved such that they bend back medially before the gula ends. Submentum about ½ the length of the gula. Mentum fused to the submentum, about the same length as the submentum. Mandibles nearly symmetrical, shaped as in Figs. 5D and 5E with a row of extremely fine teeth on the inner surfaces. Maxillae shaped as in Fig. 5A; palpi 5-segmented. Labium shaped as in Fig. 5A; palpi 4-segmented. Labrum shaped as in Fig. 5B.

Pronotum longer than wide, shaped as in Fig. 1D. Hypomera somewhat reflexed ventrally but extending inward only about ⅛ the width of the pronotum. Prosternum evenly rounded between the legs but coming to an acarinate keel; with short antero-lateral articulation processes. Prothoracic coxal cavities closed behind by membrane in which are located the heavily sclerotized mesothoracic peritremes. Elytra without distinction, shaped as in Fig. 6D, lateral borders not reflexed ventrally. Mesosternum about equal in length to the metasternum. Mesothoracic intercoxal process long and thin and extending into the posterior borders of the mesothoracic acetabulae where it is fused to the metasternum. Mesocoxal acetabulae margined. Pro-, meso-, and metalegs shaped as in Figs. 6B, 6C, and 6A respectively; tarsal formula 5-5-5.

Abdomen not physogastric, shaped as in Fig. 1D. Segment I represented only by the tergite fused to the metanotum. Segment II represented only by a tergite which is exceptionally large in this genus. Segments III-VII with 1 tergite, 1 sternite, and 2 pairs of paratergites each. Dorsal rim of the abdomen is formed between the sternites and the outer paratergites. Outer paratergites and inner paratergites about equal in width. Segment VIII represented by a tergite and sternite only. Segment IX trilobed, shaped as in Fig. 5C, with specially modified setae on the median portion. Female spermatheca sclerotized, presumed variable by species. Male genitalia bulbous, presumed variable by species.

TYPE-SPECIES: **Hodoxenus sheasbyi**, n. gen., n. sp.

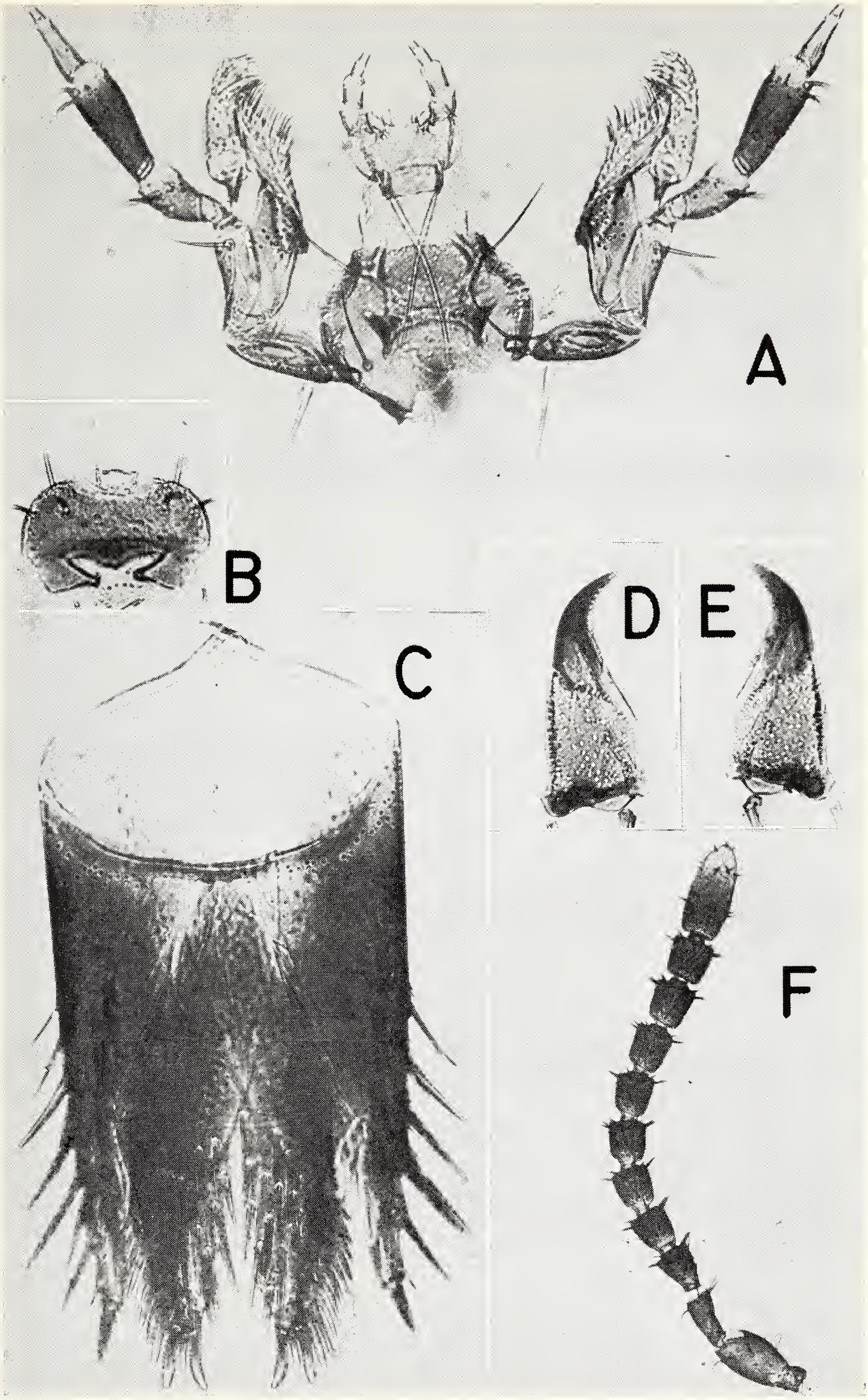

Fig. 5. **Hodoxenus sheasbyi**: A, Maxilla, labium and broken mentum; B, Labrum; C, Abdominal segment IX; D, Left mandible; E, Right mandible; F, Antenna. Scale arbitrary, see description for measurements.

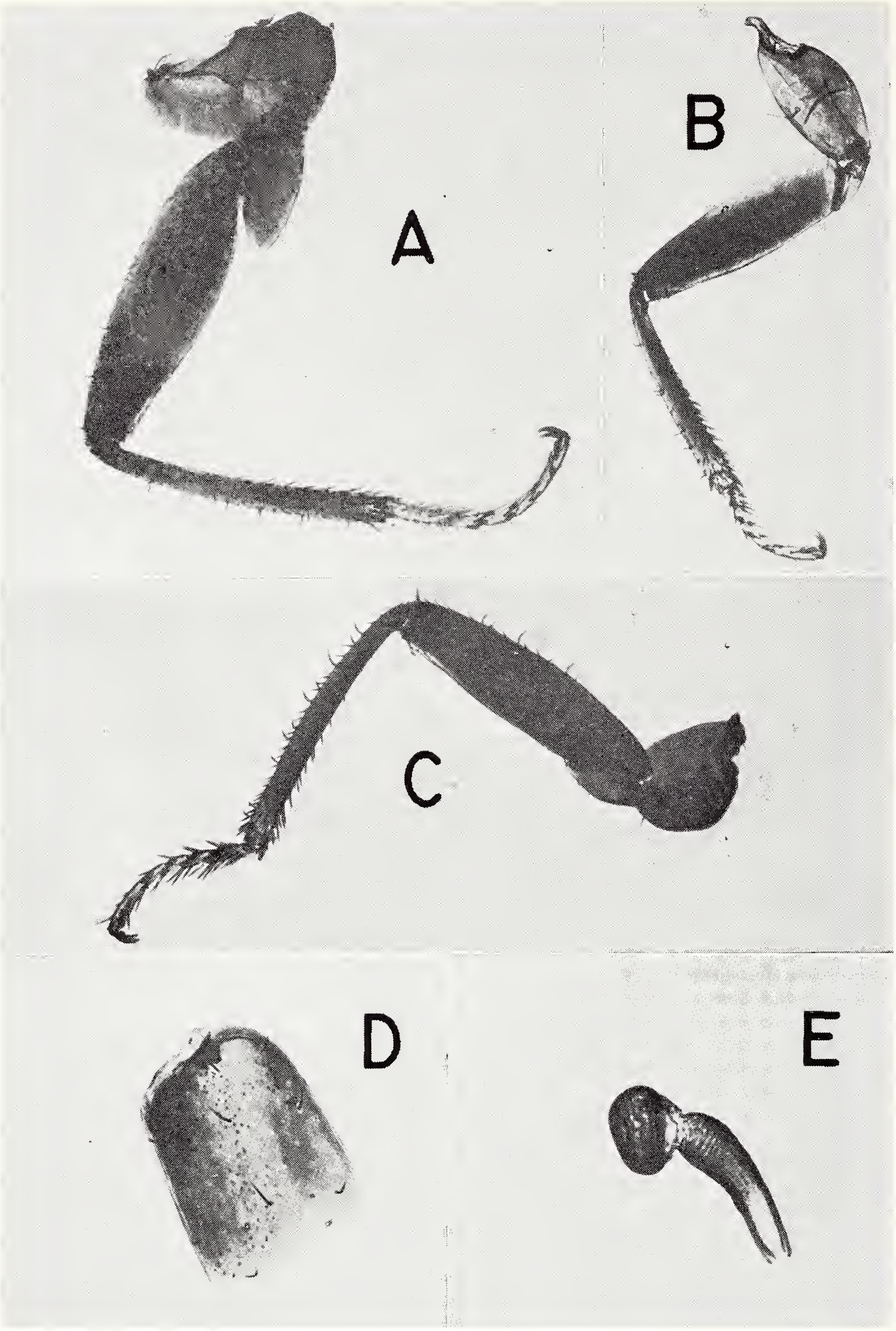

FIG. 6. **Hodoxenus sheasbyi**: A, Metaleg; B, Proleg; C, Mesoleg; D, Elytron; E, Spermatheca. Scale arbitrary, see description for measurements.

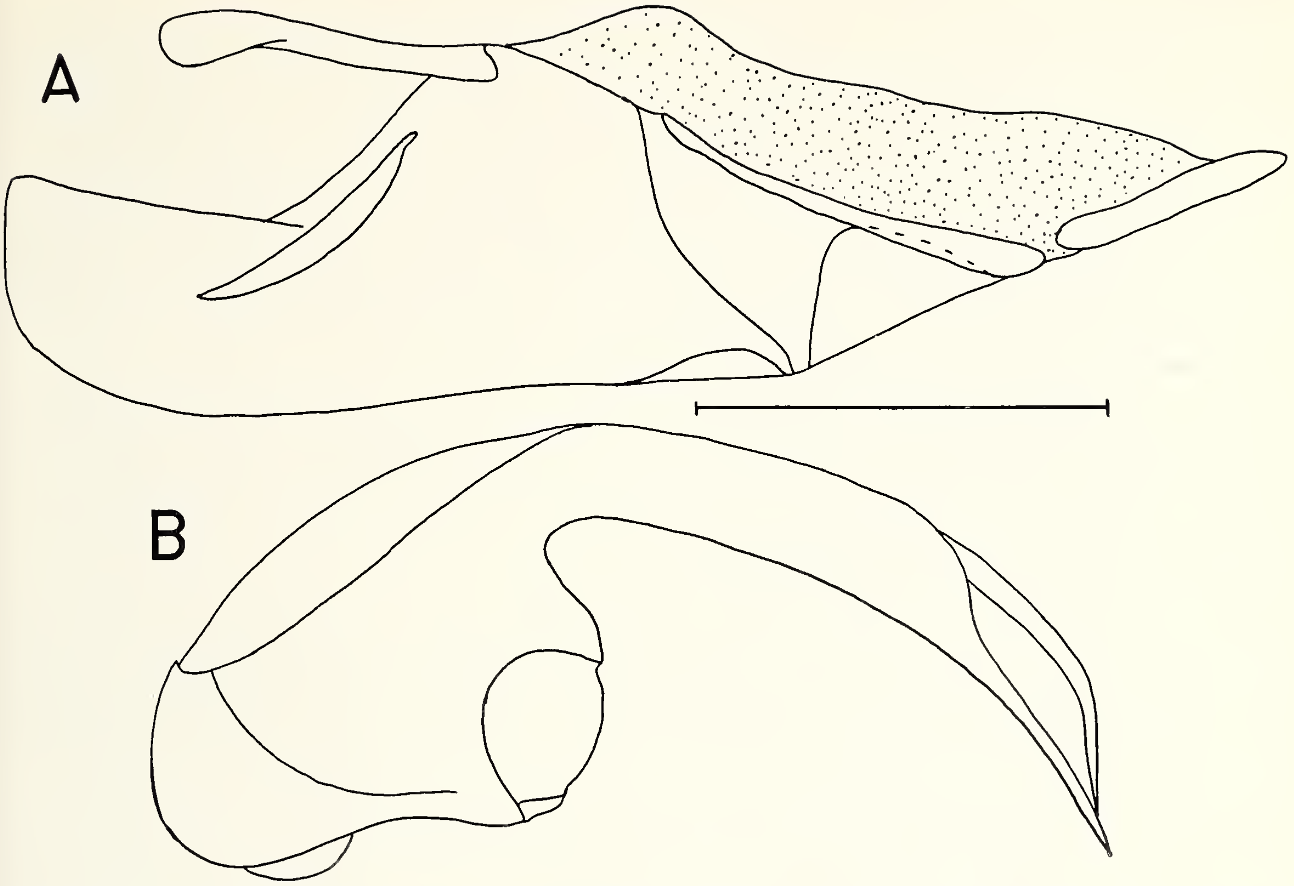

Fig. 7. **Hodoxenus sheasbyi**: A, Lateral lobe of male genitalia; B, Median lobe of male genitalia. Scale represents 0.25 mm and applies to both figures.

Hodoxenus sheasbyi, n. sp.
Figs. 5–7

Since this genus is presently monobasic, the characters isolated here as specific are based upon experience with other genera.

Color dark reddish-brown throughout, approaching black; hypomera and appendages somewhat lighter. Dorsal surface of head, pronotum, elytra and abdomen smooth and shiny. Head with no large setae. Pronotum with all 4 borders with 4 macrosetae of which they share the corner macrosetae. There are 4 additional setae across the middle of the disk. Elytra with 3 lateral macrosetae, of which 2 are on the first half and 1 toward the rear corner, and a row of 2 setae on each disk. Macrochaetotaxy of abdominal tergites II-VIII as follows: 2,6,6,6,6,6-6,4-6. Sternites III-V with sparse apical rows of longer setae. Sternites VI-VII with an apical row and an anteapical row of slightly longer setae. Sternite VIII with many setae; the rows break down because of the numbers. Male genitalia shaped as in Fig. 7. Female spermatheca shaped as in Fig. 6E.

Measurements: Head length, 0.50–0.52; pronotum length, 0.37–0.45; elytra length, 0.34–0.39. Number measured, 10.

Holotype: 1, No. 13611, Republic of South Africa, Cape Province, 20 mi ex Loeriesfontein-Nieuwoudtville, 28 April 1968, Coll. J. L. Sheasby, No. T-678. In the National Collection of Insects, Pretoria.

Paratypes: Republic of South Africa, Cape Province: 1, same data as holotype, (DK); 1, 16 mi ex Klaarstroom-Prince Albert, 15 October 1963, Coll. J. L. Sheasby, No. T-193, (NCI); 2, 15 mi ex Carnarvon-Williston, 24 April 1968, Coll. J. L. Sheasby, No. T-667, (NCI, DK); 3, 20 mi ex Loeriesfontein-Nieuwoudtville, 26 April 1968, Coll. J. L. Sheasby, No. T-674, (NCI, DK); 1, at Nieuwoudtville, 1 May 1968, Coll. J. L. Sheasby, No. T-684, (NCI); 1, same locality, 2 May 1968, Coll. J. L. Sheasby, No. T-685, (NCI); 3, same locality and date, Coll. J. L. Sheasby, No. T-689, (NCI, DK); 1, at Van Rhynsdorp, 4 May 1968, Coll. J. L. Sheasby, No. T-692, (NCI).

Notes: The host termites are in the National Isoptera Collection, Pretoria, under accession numbers TM 23049, TM 12600, TM 23017, TM 23045, TM 23080, TM 23081, TM 23083, and TM 23110 respectively. The species is named for the collector, Mr. J. L. Sheasby.

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New Termitophiles[1] Associated with *Longipeditermes longipes* (Haviland)[2] II. The Genera *Compactopedia*, *Emersonilla*, *Hirsitilla*, and *Limulodilla*[3]

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Abstract: Four new genera, **Compactopedia**, **Emersonilla**, **Hirsitilla**, and **Limulodilla**, are described from Sarawak and Malaya. The 4 genera have 4 species which are all new. These are **Compactopedia compactus** from Sarawak and Malaya, **Emersonilla longipes** from Sarawak, **Hirsitilla hirsutus** from Sarawak, and **Limulodilla limulodes** from Malaya and Sarawak. Three of the new genera (all except **Limulodilla**) are related to each other and make up a new subtribe, Compactopedina, of the tribe Aleocharini. The other genus, **Limulodilla**, belongs to the subtribe Termitozyrina of the tribe Myrmedoniini. All specimens were captured in association with *Longipeditermes longipes* (Haviland).

The purpose of this paper is to describe four new genera of termitophiles collected by Professor Alfred E. Emerson, University of Chicago, on his Oriental field trip in 1963. All of the genera which are all represented by new species, were taken from nests of *Longipeditermes longipes* (Haviland) from which termite genus no previous termitophiles have been known. In a previous paper (Kistner 1969), two other new genera with five new species were described. At least one more paper will be necessary to finish the description of new forms taken with this species of termite. I wish to thank Dr. Emerson for providing the specimens which form the basis of this paper, for determining the host termites, and for reading and commenting on this paper. All types of the specimens described herein are in the collection of the author. Specimens of the host termites are in the Emerson collection of the American Museum of Natural History, New York, and representative series are in the collection of the author. All measurements are in mm and techniques involved in the study of the specimens are given by Kistner (1968).

Acknowledgments: I wish to thank David Harwood, Lynette Hawver, Herbert Jacobson, Lynn Royce, and Virginia Sleppy, all of Chico State College, for technical assistance.

[1] Coleoptera: Staphylinidae.

[2] Isoptera: Nasutitermitinae.

[3] This study was supported in part by the National Science Foundation (Grant No. GB-12668).

New York Entomological Society, LXXVIII: 17–32. March, 1970.

Subtribe Compactopedina, n. subtribe

Three of the new genera described herein, **Compactopedia**, **Emersonilla**, and **Hirsitilla**, form a new subtribe of the tribe Aleocharini. All three of the genera are related to *Aleochara* through the remarkable mouthparts with the 5-segmented maxillary palpi and 4-segmented labial palpi together with the shape of the mentum as well as a vague similarity of the ninth abdominal segment to that genus. This subtribe is easily recognized and distinguished from other subtribes of the Aleocharini by the precise shape of abdominal segment IX.

The theoretical relationships of the three genera to each other will be discussed in a subsequent paper on the relationships of all of the termitophiles associated with *Longipeditermes*.

Key to the Genera of the Subtribe Compactopedina

1. Pronotum completely covering the head; shaped as in Fig. 1 .... **Compactopedia**, n. gen.
1′ Head not completely overlapped by the pronotum 2
2. Antennae with the petioles completely covered by extensions of the lateral sides of the segments, as in Fig. 24 .... **Emersonilla**, n. gen.
2′ Petioles of the antennae distinct; shaped as in Fig. 41 .... **Hirsitilla**, n. gen.

Genus **Compactopedia**, n. gen.

Most closely related to **Emersonilla** from which it is distinguished by the insertion of the head, which in **Compactopedia** is completely set beneath the pronotum. There are also less noticeable differences in the shape of the mandibles, abdominal segment IX, and the relative compactness of the antennae.

Overall shape as in Fig. 1. Head capsule wider than long with the epicranium produced into a long subtriangular process anteriorly. This process makes the antennal fossae appear deeply set. The triangular process broadens out anteriorly to form the normal shaped but smaller postclypeus. Capsule otherwise oval in shape with large well-developed eyes with many laterally and anteriorly directed facets. Head is normally inserted deeply under and obscured by the large pronotum as in Fig. 1. Antennae 11-segmented, shaped as in Fig. 14, short, and with the petioles of segments 3-11 protected by the extension of the sides of the segments. Gula short, with the sides diverging from anterior to posterior. Submentum broadly expanded anteriorly. Mentum distinct from the submentum, shaped as in Fig. 9. Mandibles nearly symmetrical, shaped as in Figs. 5 and 6, with a row of fine teeth-like ridges along the interior border; without mandibular teeth. Maxillae shaped as in Fig. 10; palpi 5-segmented. Maxillary acetabula distinctly margined. Labium shaped as in Fig. 9; palpi 4-segmented. Labrum shaped as in Fig. 8.

Pronotum wider than long, shaped as in Fig. 1, with the anterior border evenly rounded into the lateral borders and with a double sinuate posterior border. Prosternum short (0.10), evenly rounded dorso-ventrally and without carinas of any kind; antero-lateral articular

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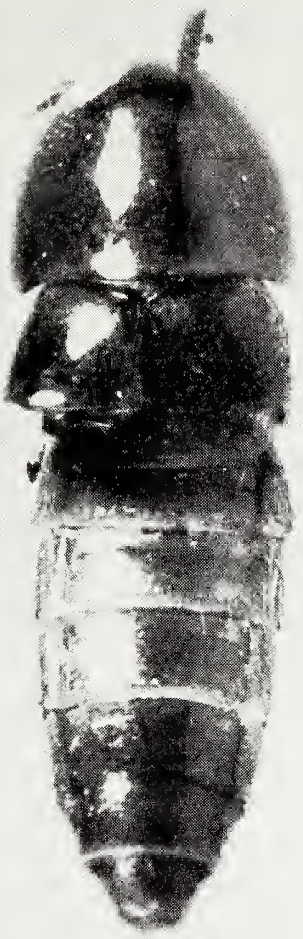
Figs. 1–4. Dorsal view of entire beetle: 1, **Compactopedia compactus**, paratype; 2, **Emersonilla longipes**, holotype; 3, **Hirsitilla hirsutus**, holotype; 4, **Limulodilla limulodes**, holotype. Scale arbitrary, see description for measurements.



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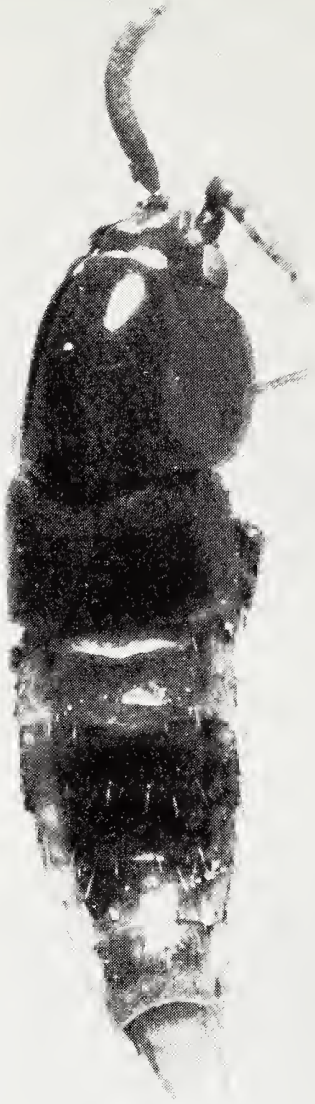

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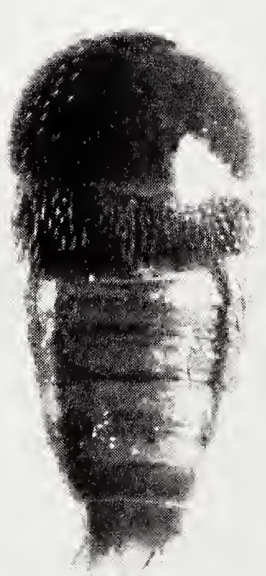

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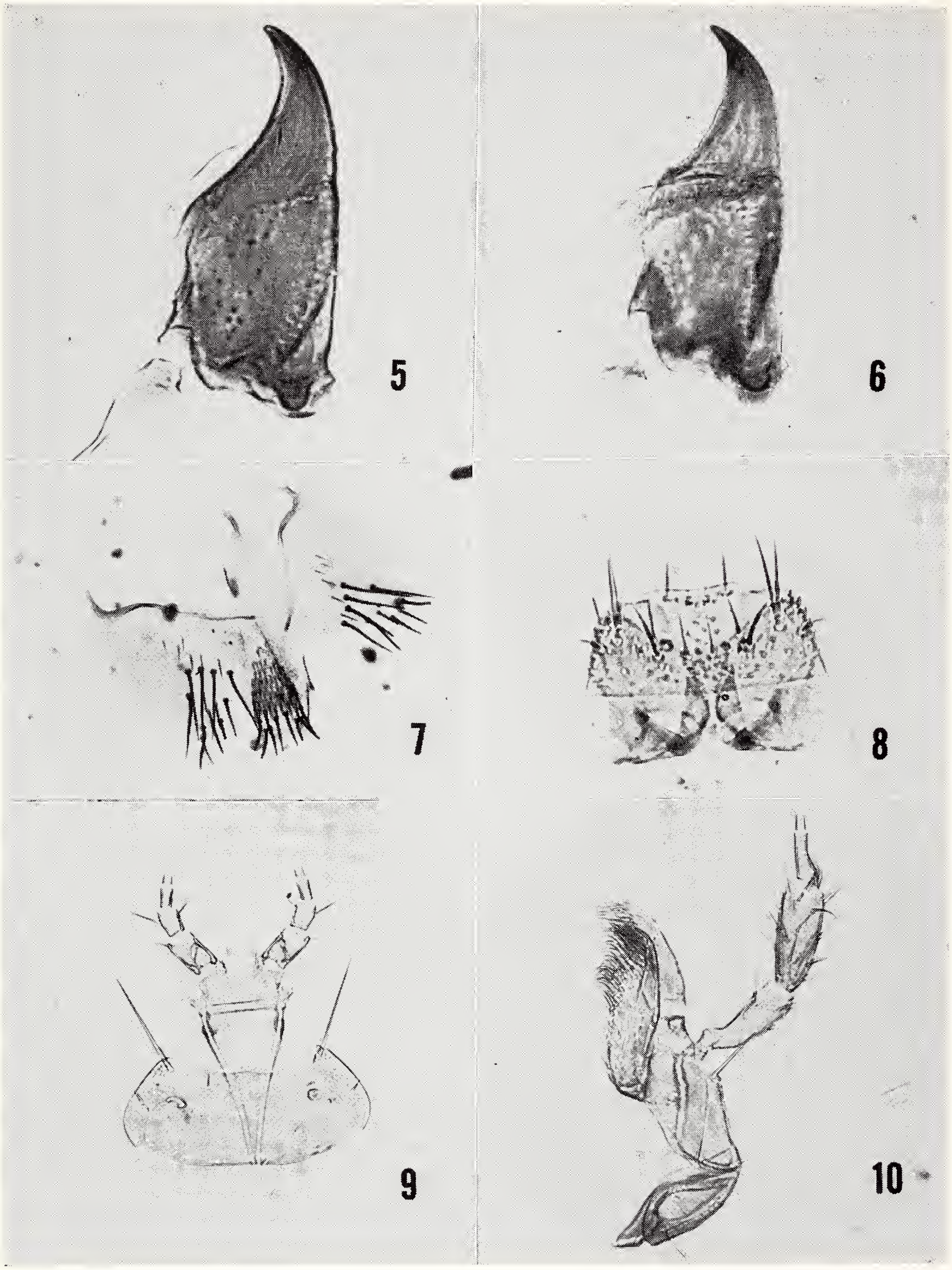
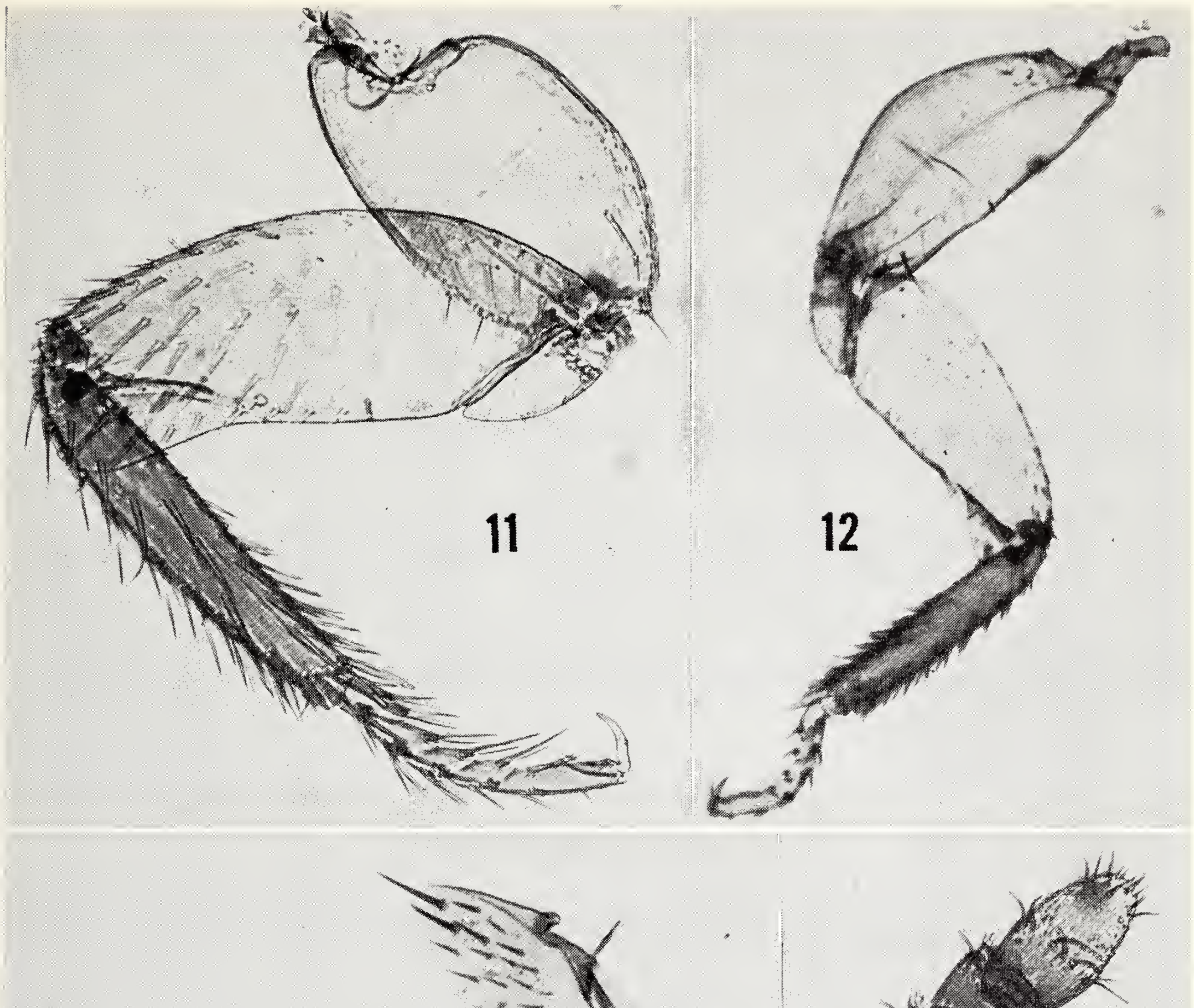


Figs. 5–10. **Compactopedia compactus**: 5, Left mandible; 6, Right mandible; 7, Abdominal segment IX of male; 8, Labrum; 9, Labium and mentum; 10, Maxilla. Scale arbitrary, see description for measurements.



Figs. 11–14. **Compactopedia compactus**: 11, Mesoleg; 12, Proleg; 13, Metaleg; 14, Antenna. Scale arbitrary, see description for measurements.

processes of normal length. Mesothoracic peritremes membranous. Elytra without distinction, shaped as in Fig. 1. Wings present, of normal size, and with the usual staphylinid venation. Metasternum about twice the length of the mesosternum; both short. Mesocoxal acetabula completely margined. Mesosternal intercoxal process blunt, broad, and acarinate. Pro-, meso- and metalegs shaped as in Figs. 12, 11, and 13 respectively; tarsal formula, 5-5-5.

Abdomen not physogastric, shaped as in Fig. 1. Segment I represented only by the tergite fused to the metanotum. Segment II represented only by a tergite. Segments III-VII with 1 tergite, 1 sternite, and 2 pairs of paratergites each. Segment VIII represented by a tergite and sternite only. Dorsal margin of the abdomen occurs between the sternites and the outer paratergites. Segment IX trilobed, shaped as in Fig. 7, anterior apodemes of male not very conspicuous. Female unknown. Male genitalia bulbous, presumed variable by species.

Type-species: **Compactopedia compactus**, n. gen. and n. sp.

Compactopedia compactus, n. sp.

Figs. 1, 5–14, 15, 17

Since this genus is presently monobasic, characters isolated as specific are based on experience with other genera.

Color reddish-brown throughout. Dorsal surface of the entire beetle smooth and shiny with very few punctures and even fewer fine yellow setae. Head with no conspicuous setae. Pronotum with a marginal row of fine sparse setae (less than 0.03 long). Elytra with a marginal row of longer black setae and 3 longitudinal rows of yellow setae extending from the lateral edge to a very short distance medial to the lateral edge. Macrochaetotaxy of abdominal tergites II-VIII: 6,6,6,6,6,6,4-6. These black setae are interspersed with an apical row of yellow setae. There are numerous other yellow setae on the tergites, paratergites, and sternites. One small black seta on each outer paratergite. Each sternite with 2 black setae at the very lateral posterior edge on each side, plus an anteapical row of very short black setae. Female unknown. Median and lateral lobes of the male genitalia shaped as in Fig. 15 and 17 respectively.

Measurements: Head length, 0.40; pronotum length, 0.75–0.98; prosternum length, 0.10; elytra length, 0.26–0.37. Number measured, 3.

Holotype: 1, No. 13575, Sarawak, 1°38′ N., 113°35′ E., 950 ft, 7 February 1963, Coll. A. and Eleanor Emerson and W. King, ex nest in hard log. In Kistner collection.

Paratypes: 1, same data as holotype, (DK); 1, same locality, date, and collectors, in cells under log near nest, (DK); 1, Malaya, Sungei Buloh Forest Reserve, 3°10′ N., 101°34′ E., 18 March 1963, Coll. A. and Eleanor Emerson, C. M. Low and R. D. Menon, near queen, (DK).

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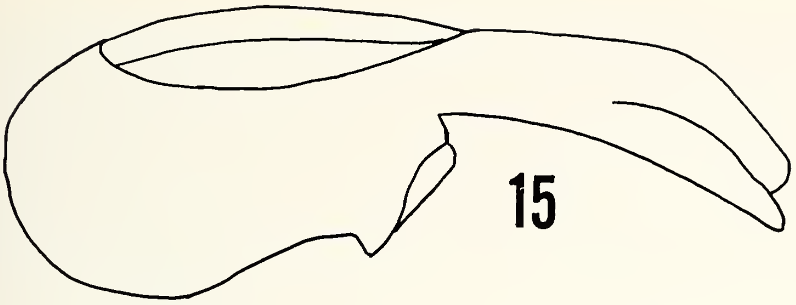
Figs. 15–21. Median lobes of male genitalia: 15, **Compactopedia compactus**; 16, **Emersonilla longipes**; 18, **Hirsitilla hirsutus**; 19, **Limulodilla limulodes**. Lateral lobes of male genitalia: 17, **Compactopedia compactus**; 20, **Limulodilla limulodes**; 21, **Hirsitilla hirsutus**. The scale represents 0.25 mm and applies to all figures.



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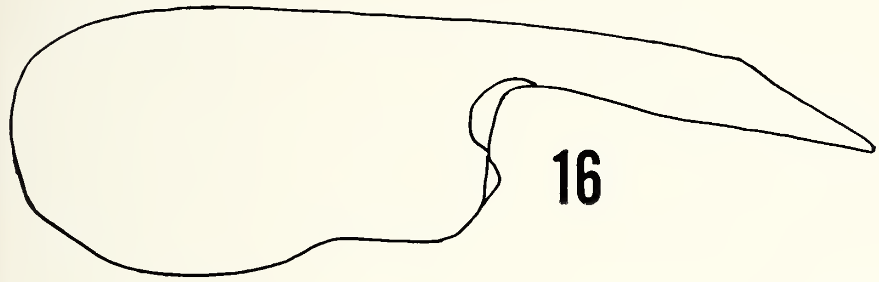

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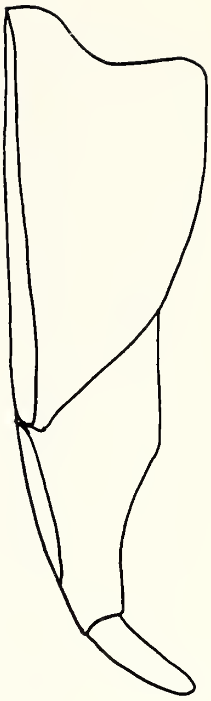

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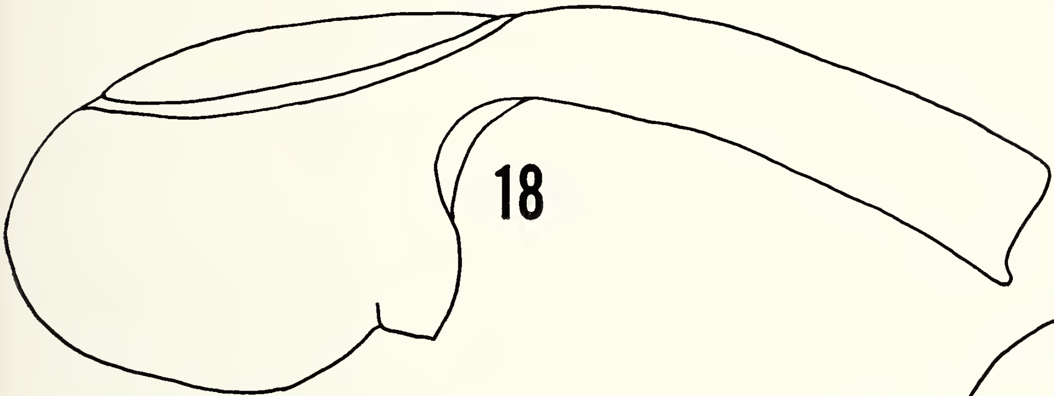

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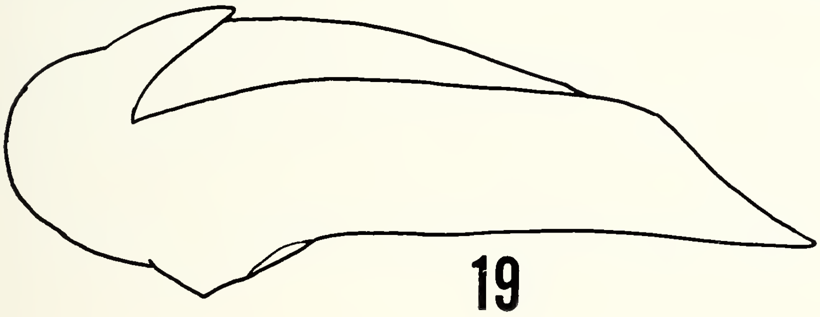

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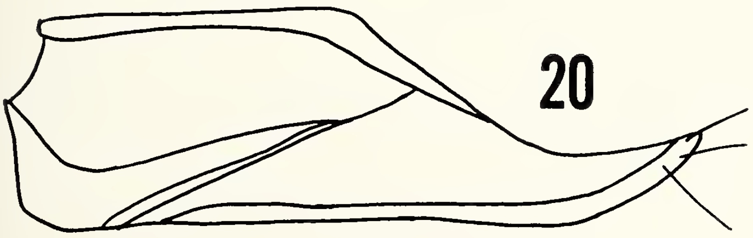

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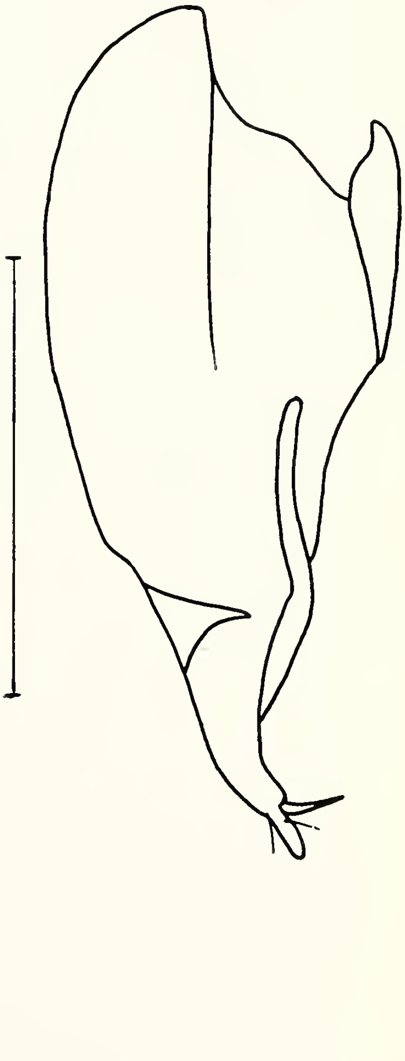

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Genus **Emersonilla**, n. gen.

Most closely related to **Compactopedia** from which it is distinguished by its head not being totally covered by the pronotum, its more angular pronotum, and its longer antennae.

Overall shape as in Fig. 2. Head capsule wider than long with the epicranium produced into a long subtriangular process anteriorly. This process (visible in Fig. 2) makes the antennal fossae appear deeply set. The triangular process broadens out anteriorly to form the normal-shaped but smaller postclypeus. Capsule otherwise oval in shape with large well-developed eyes with many laterally and anteriorly directed facets. Head is only partly covered by the pronotum at the posterior border. Antennae inserted between the eyes; at the medial border of the eyes and between the eyes and the anterior tentorial pits. Antennae 11-segmented, shaped as in Fig. 24; petioles covered by extensions of the sides of the segments. Note that this antennae is longer than that of **Compactopedia** by comparing in Figs. 1 and 2 and that each segment is proportionately longer (cf Fig. 14 and 24). Gula short with the sides diverging from anterior to posterior. Submentum (fused to the gula) broadly expanded anteriorly. Mentum distinct from the submentum, shaped as in Fig. 26. Mandibles nearly symmetrical, shaped as in Fig. 22 and 23. Maxillae shaped as in Fig. 27, palpi 5-segmented. Maxillary acetabula distinctly margined. Labium shaped as in Fig. 26, palpi 4-segmented. Labrum shaped as in Fig. 25.

Pronotum wider than long, shaped as in Fig. 2, with the anterior border making a distinct angle at each lateral border so that all 4 borders are distinct. Posterior border with a double sinuate curve. Prosternum short (0.10), evenly rounded medially, acarinate, with normal length antero-lateral articular processes. Mesothoracic peritremes membranous. Elytra without distinction, shaped as in Fig. 2. Wings present, of normal size, and with the usual staphylinid venation. Metasternum about twice the length of the mesosternum; both short. Mesocoxal acetabulae completely margined. Mesosternal intercoxal process blunt, broad, and acarinate. Pro-, meso-, and metalegs shaped as in Fig. 28, 31, and 29 respectively. Note that the tarsi are longer in relation to the rest of the leg in this genus as compared with **Compactopedia**. Also note that the procoxae are longer. Tarsal formula 5-5-5.

Abdomen not physogastric, shaped as in Fig. 2. Segment I represented only by the tergite fused to the metanotum. Segment II represented only by a tergite. Segments III-VII with 1 tergite, 1 sternite, and 2 pairs of paratergites each. Segment VIII represented by a tergite and sternite only. Dorsal margin of the abdomen occurs between the sternites and the outer paratergites. Segment IX trilobed, shaped as in Fig. 30, anterior apodemes of male not very conspicuous. Female unknown. Male genitalia bulbous, presumed variable by species.

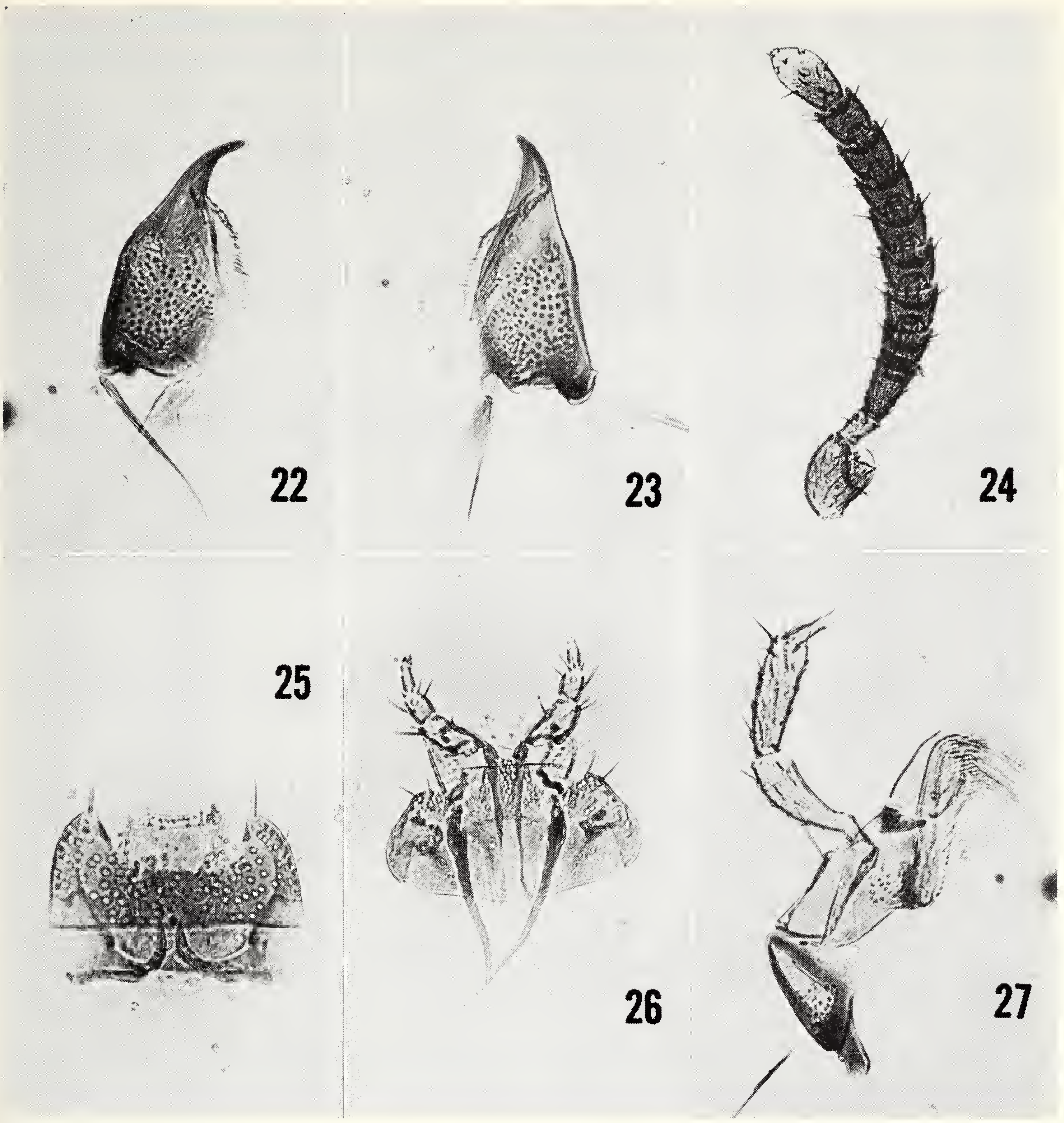
Type-species: **Emersonilla longipes**, n. gen. and n. sp.

Emersonilla longipes, n. sp.

Fig. 2, 16, 22–31

Since this genus is presently monobasic, characters isolated as specific are based on experience with other genera.

Color reddish-brown throughout. Dorsal surface of entire beetle smooth and shiny with very few punctures and even fewer fine yellow setae. Head with no conspicuous setae. Pronotum with a marginal row of fine sparse setae (less than 0.03 mm long). Elytra with 4 marginal longer setae plus 1 on disk. Macrochaetotaxy of abdominal tergites II-VIII: 2,6,4-2,4-2,4-2,4-4,4-6. When 2 figures are given, the 1st figure represents an anteapical row

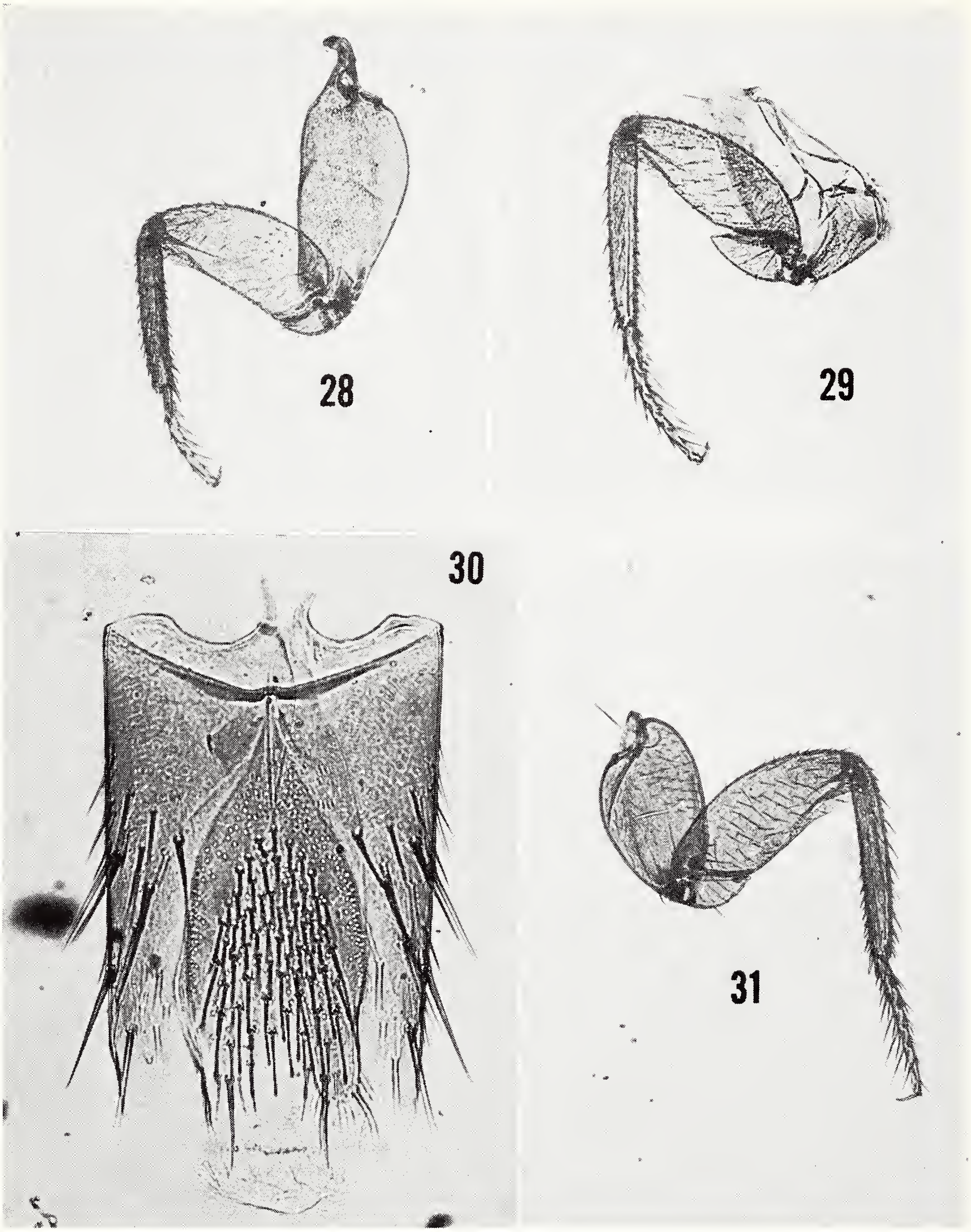


Figs. 22–27. **Emersonilla longipes**: 22, Left mandible; 23, Right mandible; 24, Antenna; 25, Labrum; 26, Labium and mentum; 27, Maxilla. Scale arbitrary, see description for measurements.

while the 2nd figure represents an apical row. On tergite VIII, the middle 2 apical setae are smaller than the rest. Each sternite with many black setae. Each outer paratergite with 1 black seta. Female unknown. Median lobe of male genitalia shaped as in Fig. 16. Lateral lobe of male genitalia shaped as in **Compactopedia**.

Measurements: Head length, 0.52; pronotum length, 0.87; prosternum length, 0.10; elytra length, 0.50. Number measured, 1.

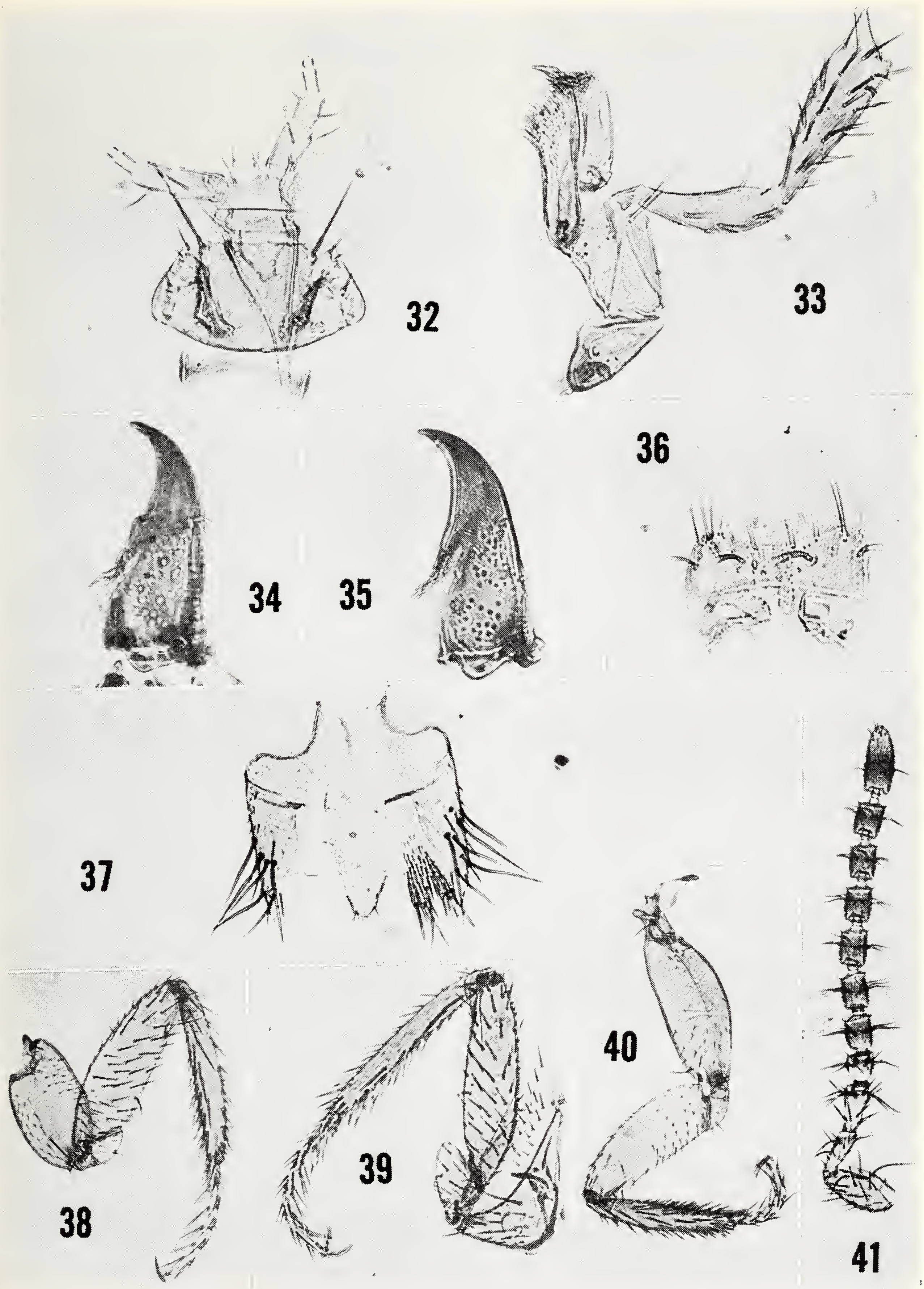
Holotype: 1, No. 13512, Sarawak, 1°38′ N., 113°35′ E., 950 ft, 7 February 1963, Coll. A. and Eleanor Emerson and W. King, ex nest in hard log. In Kistner collection.



Figs. 28–31. **Emersonilla longipes**: 28, Proleg; 29, Metaleg; 30, Abdominal segment IX of male; 31, Mesoleg. Scale arbitrary, see description for measurements.

Genus **Hirsitilla**, n. gen.

Most closely related to **Compactopedia** and **Emersonilla** from which it is distinguished by the shape of the antennae as well as the overall shape of the body.



Figs. 32–41. **Hirsitilla hirsutus**: 32, Labium and mentum; 33, Maxilla; 34, Right mandible; 35, Left mandible; 36, Labrum; 37, Abdominal segment IX of male; 38, Mesoleg; 39, Metaleg; 40, Proleg; 41, Antenna. Scale arbitrary, see description for measurements.

Overall shape of the beetle as in Fig. 3. Head capsule wider than long with the epicranium produced into a long subtriangular process anteriorly. This process makes the antennal fossae appear deeply set. The triangular process broadens out anteriorly to form the normal-shaped but smaller postclypeus. Capsule otherwise oval in shape with large well-developed eyes with many laterally and anteriorly-directed facets. Head is only partly covered by the pronotum at the posterior border. Antennae inserted between the eyes; at the medial border of the eyes and between the eyes and the anterior tentorial pits. Antennae 11-segmented, shaped as in Fig. 41, segments with the petioles exposed. Gula with the sides diverging from anterior to posterior. Submentum (fused to the gula) broadly expanded anteriorly. Mentum distinct from the submentum, shaped as in Fig. 32. Mandibles slightly asymmetrical, shaped as in Fig. 34 and 35; right mandible with a slight mandibular tooth. Maxillae shaped as in Fig. 33; palpi 5-segmented. Maxillary acetabula distinctly margined. Labium shaped as in Fig. 32; palpi 4-segmented. Labrum shaped as in Fig. 36.

Pronotum wider than long, shaped as in Fig. 3, with the anterior border evenly rounded into the lateral borders and with a double sinuate posterior border. Prosternum short (0.10), evenly rounded and acarinate; antero-lateral articular processes of normal length. Mesothoracic peritremes membranous. Elytra without distinction, shaped as in Fig. 3. Wings present, of normal size, and with the usual staphylinid venation. Metasternum about twice the length of the mesosternum; both short. Mesocoxal acetabulae completely margined. Mesosternal intercoxal process blunt, broad, and acarinate. Metasternal contribution to the mesosternal intercoxal process long, thin, but blunt and acarinate. Pro-, meso-, and metalegs shaped as in Figs. 40, 38, and 39 respectively; tarsal formula, 5-5-5.

Abdomen not physogastric, shaped as in Fig. 3. Segment I represented only by the tergite fused to the metanotum. Segment II represented only by a tergite. Segments III-VII with 1 tergite, 1 sternite, and 2 pairs of paratergites each. Segment VIII represented by a tergite and sternite only. Segment IX trilobed, shaped as in Fig. 37, anterior apodemes of male not very conspicuous. Female unknown. Male genitalia bulbous, presumed variable by species. Dorsal margin of the abdomen occurs between the sternites and the outer paratergites.

Type-species: **Hirsitilla hirsutus**, n. gen. and n. sp.

Hirsitilla hirsutus, n. sp.

Figs. 3, 18, 21, 32–41

Since this genus is presently monobasic, characters isolated as specific are based on experience with other genera.

Color reddish-brown throughout, head and appendages somewhat lighter than the rest of the body, approaching yellowish-red. Dorsal surface of the entire beetle smooth and shiny but with many setae. Head with many scattered light yellow setae. Pronotum with a marginal row of about 26 setae on the anterolateral margin, about 4 on the posterior margin, and 2 on the center and 2 on each side of the disk. Besides the longer setae which make up the above counts, there are many shorter lighter setae. Each elytron contains 3 large black setae; 2 on the lateral margin and 1 on the disk in addition to many shorter lighter setae. Macrochaetotaxy of abdominal tergites II-VIII: 2 apical, 6,6,6,6,6,4-4. Tergites III-VI have

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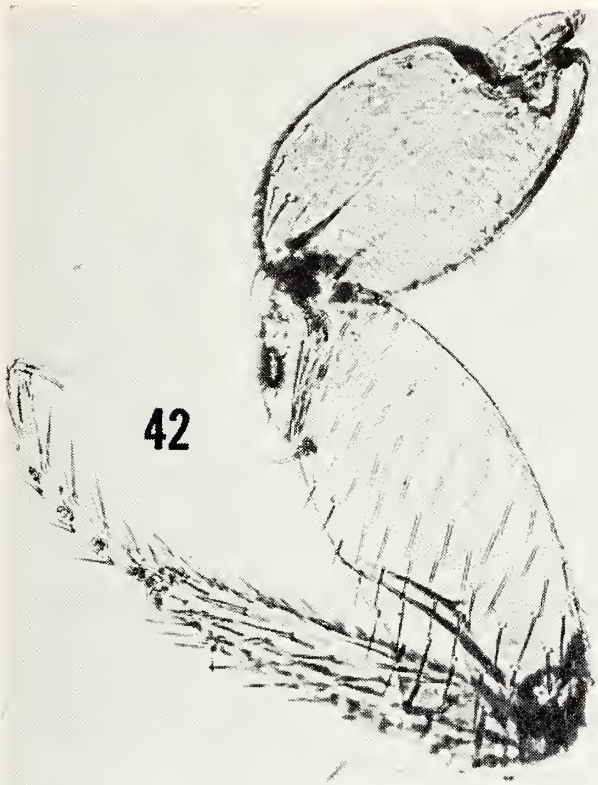
Figs. 42–47. **Limulodilla limulodes**: 42, Mesoleg; 43, Proleg; 44, Abdominal segment IX of male; 45, Coxa of metaleg; 46, Metaleg; 47, Elytron. Scale arbitrary, see description for measurements.



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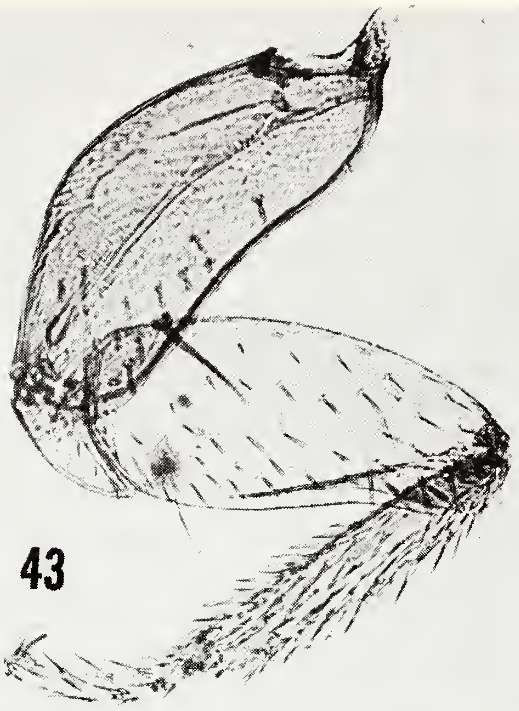

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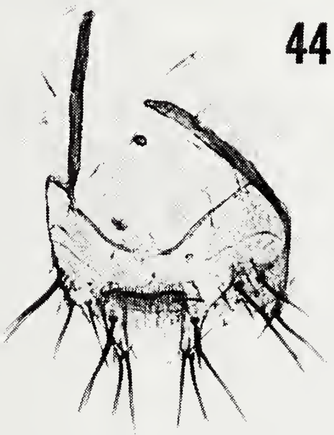

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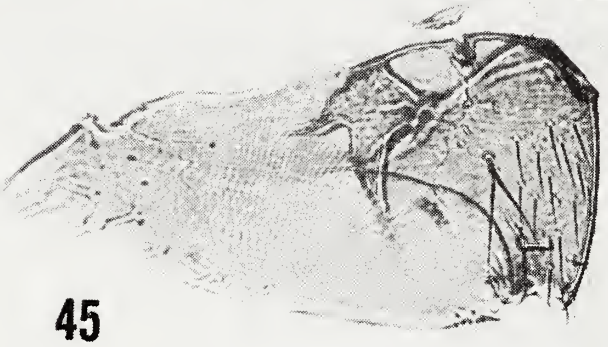

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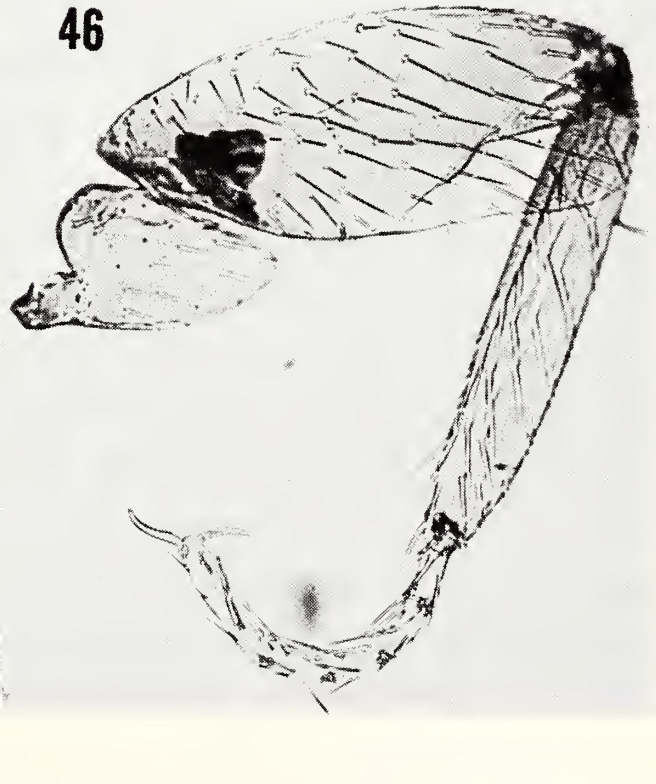

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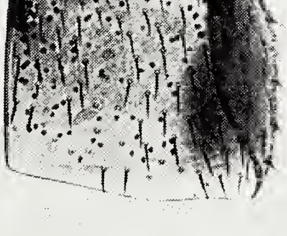

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an additional apical row of finer yellow setae. All sternites with many fine yellow setae. One macrochaeta on each outer paratergite. Female unknown. Median and lateral lobes of the male genitalia shaped as in Figs. 18 and 21 respectively.

Measurements: Head length, 0.27; pronotum length, 0.64; prosternum length, 0.10; elytra length, 0.34. Number measured, 1.

Holotype: 1, No. 13514, Sarawak, 1°38′ N., 113°35′ E., 950 ft, 7 February 1963, Coll. A. and Eleanor Emerson and W. King, ex nest in hard log. In Kistner collection.

The following genus belongs to the subtribe Termitozyrina of the tribe Myrmedoniini, subfamily Aleocharinae.

Genus **Limulodilla**, n. gen.

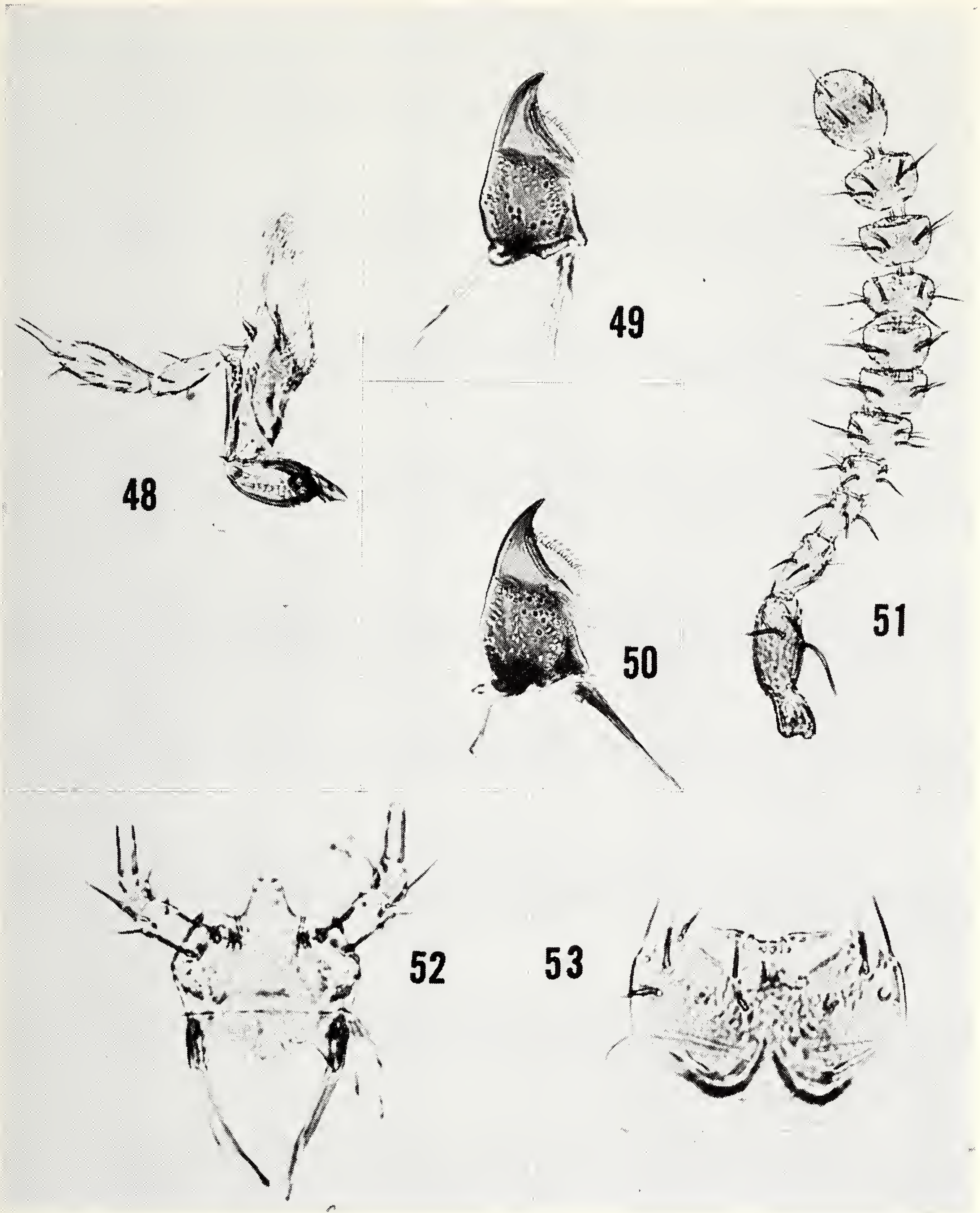
Closely related to *Termitozyras* Seevers from which it is distinguished by its more compact form, the shape of the antennae, and the shape of the abdomen. The similarity in the structure of abdominal segments IX is most striking in spite of the overall differences in the shape of the 2 genera.

Overall shape as in Fig. 4. Head capsule wider than long with the epicranium not produced into a long subtriangular process anteriorly. It is produced into an evenly rounded shelf over the clypeus instead. Capsule otherwise more or less oval in shape with large well-developed eyes with many laterally and anteriorly directed facets. Antennae inserted between the eyes at the edge of the above-mentioned shelf and just lateral to the anterior tentorial pits. Head is only partially covered by the anterior edge of the pronotum; usually only to the nuchal ridge. Antennae 11-segmented, shaped as in Fig. 51, somewhat compressed, but with the petioles of all segments exposed. Gula of normal length, with sides very slightly divergent from anterior to posterior. Submentum (fused to the gula) broadly expanded anteriorly. Mentum distinct from the submentum. Maxillary acetabula distinctly margined. Mandibles nearly symmetrical, shaped as in Figs. 49 and 50; with only a hint of a mandibular tooth. Maxillae shaped as in Fig. 48; palpi 4-segmented. Labium shaped as in Fig. 52; palpi 3-segmented. Labrum shaped as in Fig. 53.

Pronotum wider than long, shaped as in Fig. 4 and though the anterior border is somewhat rounded into the laterals, there are nevertheless 4 distinct borders. Posterior border double sinuate in form. Prosternum short (0.08), evenly rounded dorso-ventrally, acarinate, and with articular processes of normal length. The prosternum actually looks narrow but this is a result of the lateral expansion of the prothorax such that the prosternum only occupies the middle third of the prothorax. Mesothoracic peritremes membranous. Elytra without distinction other than the broadly reflexed lateral edge; shaped as in Fig. 47. Wings present, of normal size, and with the usual staphylinid venation. Metasternum about ⅓ longer than the mesosternum; both short. Mesocoxal acetabula completely margined. Mesosternal intercoxal process blunt, broad, and acarinate. Pro-, meso-, and metalegs shaped as in Figs. 43, 42, and 45–46 respectively; tarsal formula, 4-5-5.

Abdomen not physogastric; shaped as in Fig. 4. Segment I represented only by the tergite fused to the metanotum. Segment II represented only by the tergite. Segments III-VII with 1 tergite, 1 sternite, and 2 pairs of paratergites each. Segment VIII represented by a tergite and sternite only. Dorsal margin of the abdomen occurs between the sternites and the outer paratergites. Segment IX trilobed, shaped as in Fig. 44 with moderately long anterior apodemes in the male. Female unknown. Male genitalia bulbous, presumed variable by species.

Type-species: **Limulodilla limulodes**, n. gen. and n. sp.



Figs. 48–53. **Limulodilla limulodes**: 48, Maxilla; 49, Right mandible; 50, Left mandible; 51, Antenna; 52, Labium; 53, Labrum. Scale arbitrary, see description for measurements.

Limulodilla limulodes, n. sp.

Figs. 4, 19, 20, 42–53

Since this genus is presently monobasic, the characters isolated as specific are based on experience with other genera.

Color reddish-brown throughout with head somewhat darker than the rest of the body. Head with many light yellow setae. Pronotum and elytra also with an even covering of fine yellow setae. Pronotum also with a marginal row of black setae of approximately the same length as the yellow setae. Elytra (Fig. 47) with 4 marginal setae which are somewhat longer than the yellow setae. Macrochaetotaxy of abdominal tergites II-VIII: 2,6,6,6,6,6,4. Macrochaetotaxy of abdominal sternites III-VIII: 2,2,2,2,8-8,6-6; those on sternites VII and VIII while more numerous are much smaller. Outer paratergites with 1 macrochaeta on each; inners with none. Median and lateral lobes of the male genitalia shaped as in Figs. 19 and 20 respectively.

MEASUREMENTS: Pronotum length, 0.57–0.58; elytra length, 0.30–0.31. Number measured, 2.

HOLOTYPE: 1, No. 13564, Malaya, Sungei Buloh Forest Reserve, 3°10′ N., 101°34′ E., 150 ft, 18 March 1963, Coll. A. and Eleanor Emerson, C. M. Low, and R. D. Menon, in the vicinity of the queen.

PARATYPE: 1, Sarawak, 1°38′ N., 113°35′ E., 950 ft, 7 February 1963, Coll. A. and Eleanor Emerson and W. King, Vial No. 2, ex nest in hard log.

Literature Cited

KISTNER, D. H. 1968. A taxonomic revision of the termitophilous tribe Termitopaedini, with notes on behavior, systematics, and post-imaginal growth. (Coleoptera: Staphylinidae). Misc. Publ. Entomol. Soc. Amer., **6:** 142–196.

———. 1969. New termitophiles associated with *Longipeditermes longipes* (Haviland). I. The genera *Longipedoxenus* and *Longipedisymbia*. Pan-Pacific Entomol., (**in press**).

Scanning Electron Microscopy of Antennal Structures of *Polyplax serrata* (Burmeister) (Anoplura: Hoplopleuridae)

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Abstract: The high magnification of the scanning microscope reveals that the first two antennal segments each have a sensillum placodeum, while the fourth and the fifth, the last two, each have a sensillum coelonicum. These latter sensilla are partially covered by protective plates, and from the floor of each a peg organ arises. On the apex of the peg there is a ring of eleven rudimentary hairs, and the wall of the atrium is reticulate. The third segment of the male has a distal, preaxial angled extension which bears a tooth.

The scanning electron microscope is rapidly becoming a popular tool in entomology. The resolving power and depth of focus is of such high detail that the image has a three dimensional effect. This clarity of surface structures at higher magnifications than is possible with the light microscope, enables previously overlooked or unknown to be studied. An example of this is the pore organs on the antennae of *Pediculus humanus* Linn. and *Phthirus pubis* (Linn.) as described by Miller (1969). An additional advantage of this microscope is that its fine scanning beam makes it possible to see into crevices and openings. For example, the sculpturing and reticular patterns of the spiracular atria may now be studied without having to dissect and section the organisms. When these organs are seen in their entirety, this may lead to a better understanding of the organ and the physiology of the organism, as well as to increase the use of these structures as taxonomic criteria.

The antennae of the genus *Polyplax* is described by Ferris (1923) as being five segmented, and those of the males are slightly sexually dimorphic in the third segment with a distal-preaxial angled extension terminating in a recurved spine or seta. The present study shows this spine or seta to be a tooth. The ring sensoria on the antennae referred to by Ferris (1951) are here described as sensilla coeloconica and in such clarity that the peg organ and reticulated wall of the atrium are reported in detail. Other antennal structures of *Polyplax serrata* (Burmeister) are also described.

Acknowledgments: The writer wishes to thank Miss Dolores Krause and Mrs. Carolyn Schwartz for their technical assistance, and Mr. Bill Richards for his help in the preparation of the illustrations. My sincere thanks to Doctors John L. Duffy and Irving Abrahams of the Meadowbrook Hospital and to Dr. Janardhan G. Butte of the State University of New York at Farmingdale for their discussions and reading the manuscript.

New York Entomological Society, LXXVIII: 33–37. March, 1970.

MATERIALS AND METHODS

This study is based on 48 specimens of *Polyplax serrata* (Burmeister) representing two populations. One was supplied by Dr. Austin Frishman of the State University of New York at Farmingdale, and the other from a laboratory colony maintained on mice at the Meadowbrook Hospital Laboratory. Males, females and nymphal stages were fixed in 70% alcohol. Intact lice were mounted on metal specimen holders as previously described by Miller (1969). They were studied under the scanning electron microscope, a Cambridge Steroscann Mark II, at 20kv. The general structures and characteristics of the entire organisms were scanned prior to the more detailed study of the antennae.

RESULTS AND DISCUSSION

Scanning electron microscopy of the antennae of adult male, female, and nymphal stages of *P. serrata* reveals the following. The first antennal segment of the male appears slightly dilated when compared to this segment in the female. The first segment of the male, female, and nymphal stages each has approximately seven setae of different sizes scattered over the segment. On the dorsal side, near the distal end of the first antennal segment there is a dome-like structure (Fig. 1) which measures approximately 1.6 microns in diameter. This dome, or plate, may well be a surface view of a sensillum placodeum as described by Snodgrass (1935). There are numerous short spines on the intersegmental membrane and surrounding the base of the second segment (Fig. 2). Studies of entire lice reveal similar spines between all the joints of the legs (Fig. 3). Their positions suggest that they may be the organs for recording the position of the appendages.

The second antennal segments of the males, females, and nymphal stages are morphologically similar to each other; seven setae are usually scattered on this segment. On the dorso-lateral distal end of this segment, there is a dome similar

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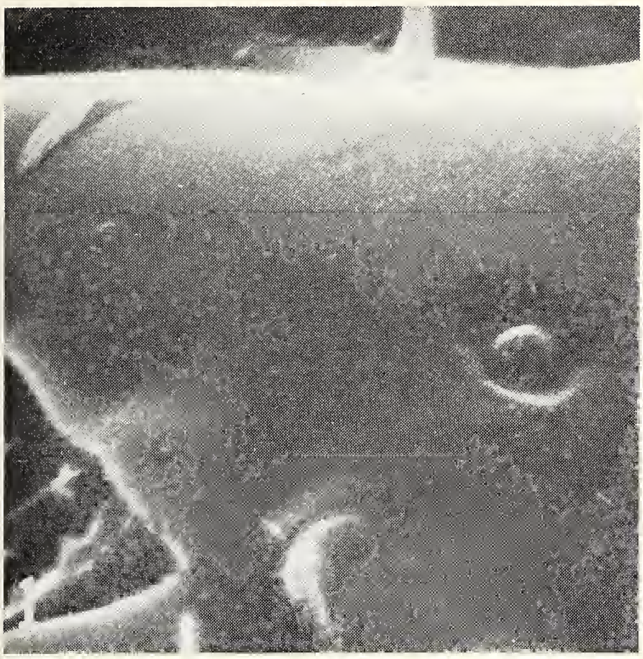
Figs. 1–12. All the photomicrographs are of the louse, *Polyplax serrata*. 1. Dome-like structure on the first antennal segment. 2,800×. 2. Spines in intersegmental membrane between the first and second antennal segments. 1,000×. 3. Spines surrounding the joint between the coxae and the trochanter of the first leg. 3,000×. 4. Dome-like structure seen on second antennal segment. 6,000×. 5. Antennal segments of the male showing sexual dimorphism of the third segment. 500×. 6. Antennal segments of the female. Note the absence of the tooth on the third segment. 600×. 7. Tooth on the third segment of the male antenna. 3,000×. 8. Protective plates around the opening on the fourth antennal segment. 3,000×. 9. Peg organ seen in base of sensillum coeloconicum. 12,000×. 10. Atrial wall of sensillum coeloconicum of fourth antennal segment showing the sculptured reticulated pattern. 7,000×. 11. Wall of respiratory atrium of the third abdominal segment showing sculptured reticulated pattern. 3,000×. 12. Terminal end of fifth antennal segment showing the cluster of setae-like structures. 1,000×.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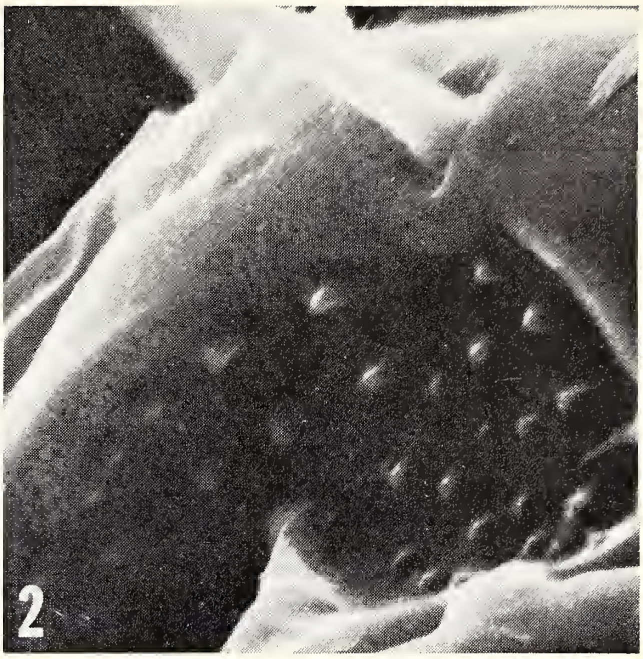
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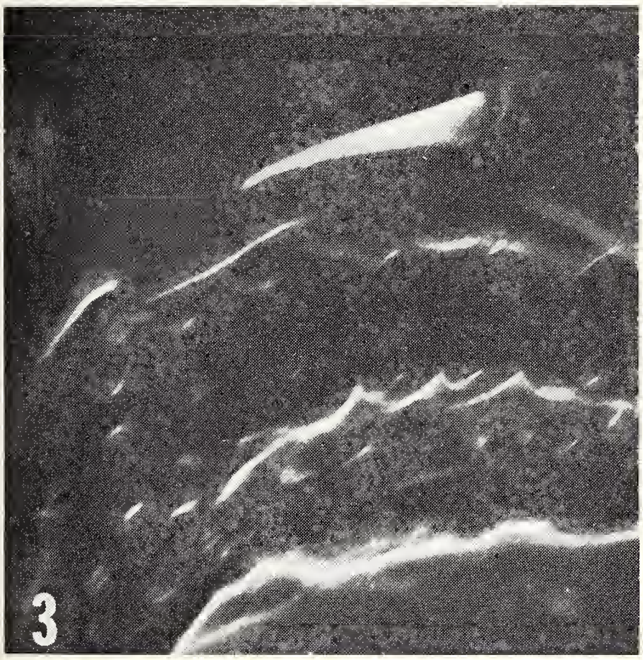
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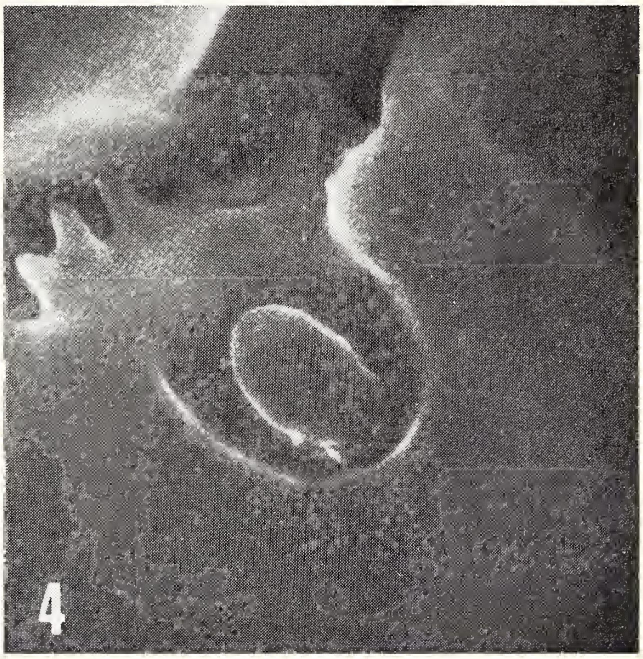
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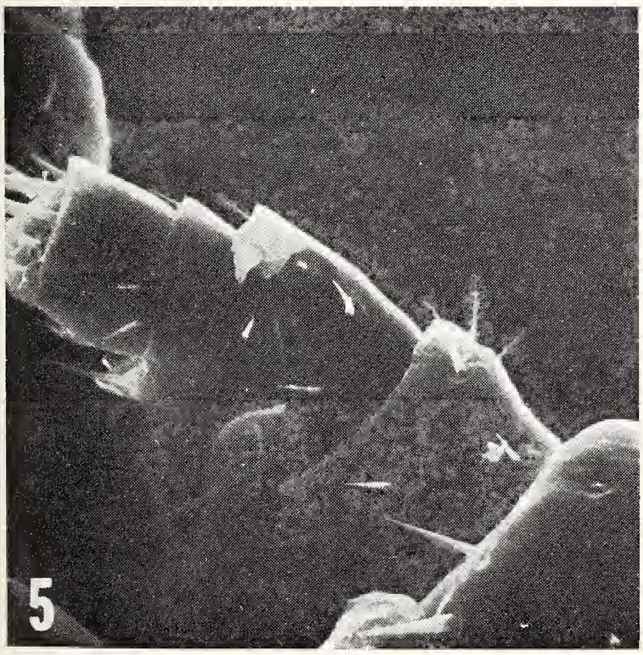
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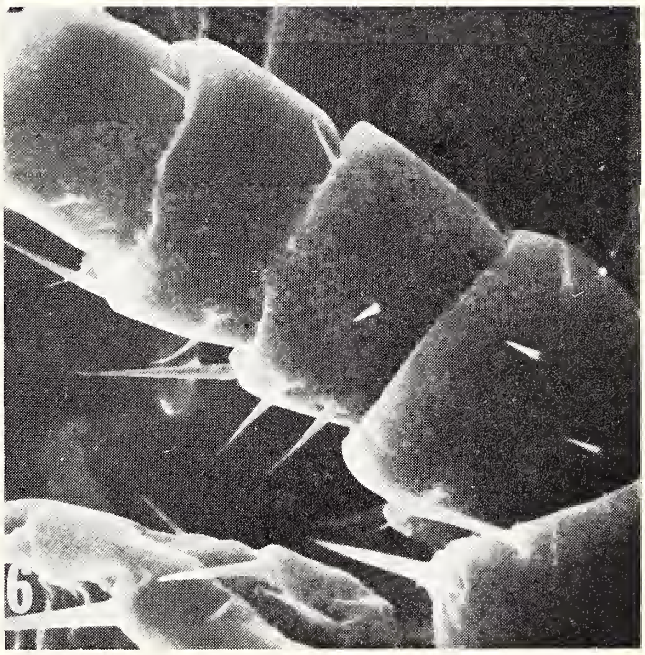
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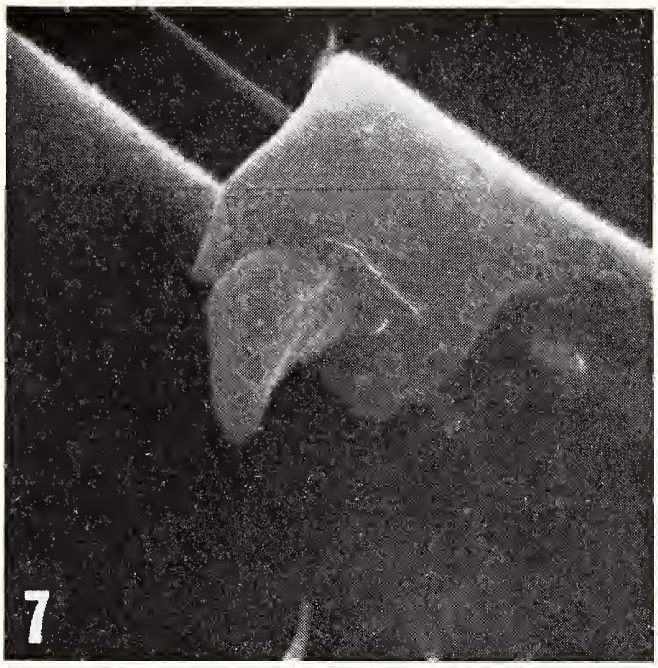
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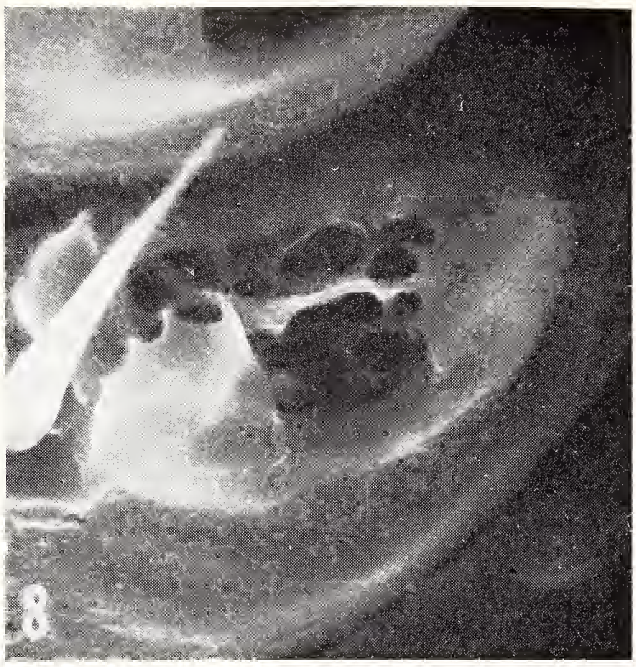
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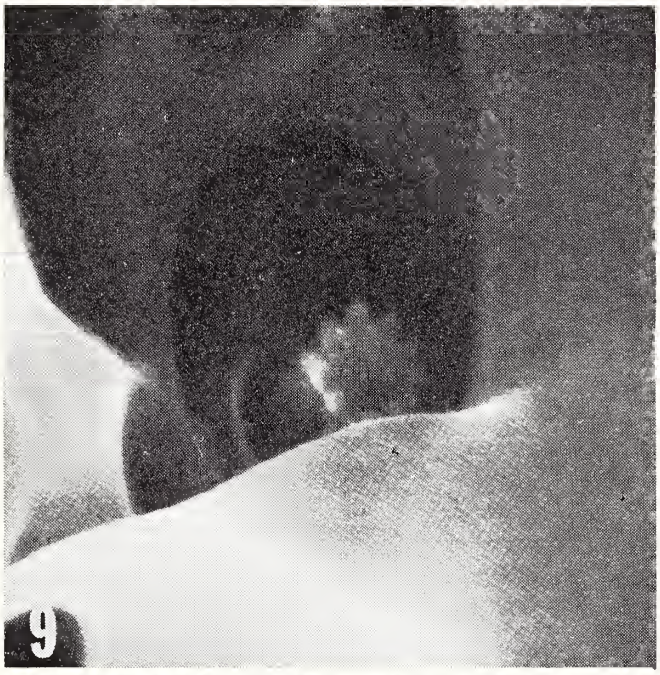
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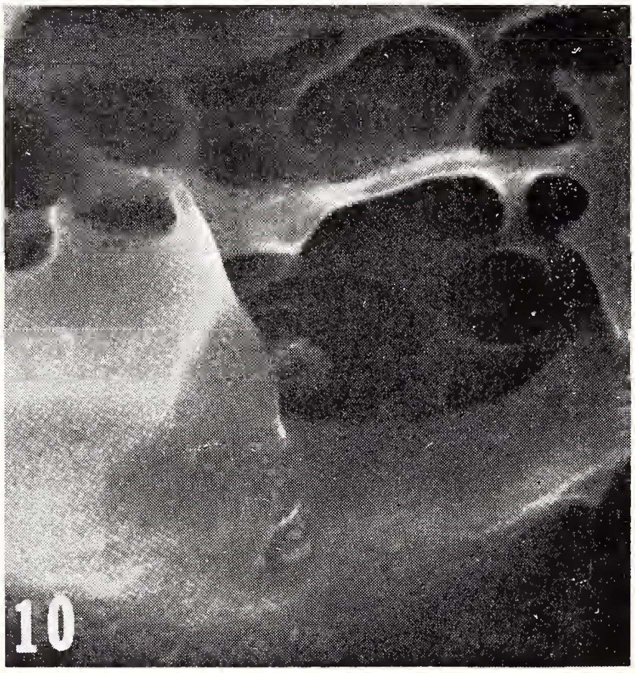
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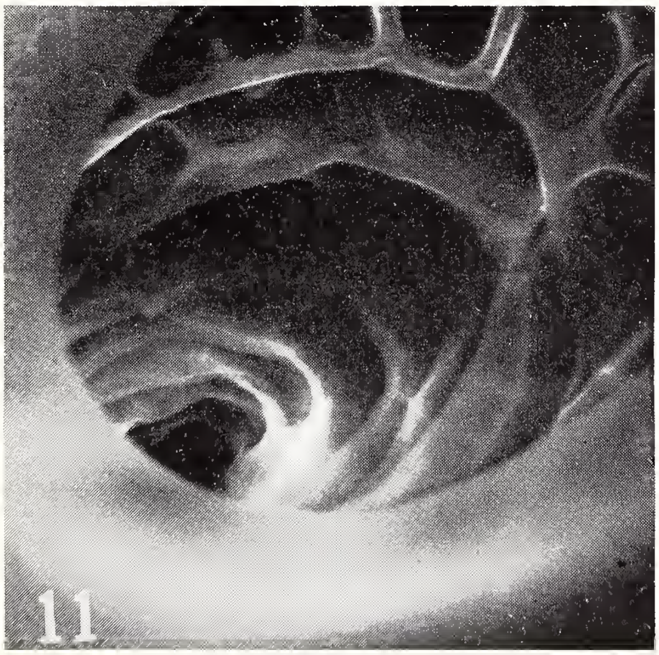
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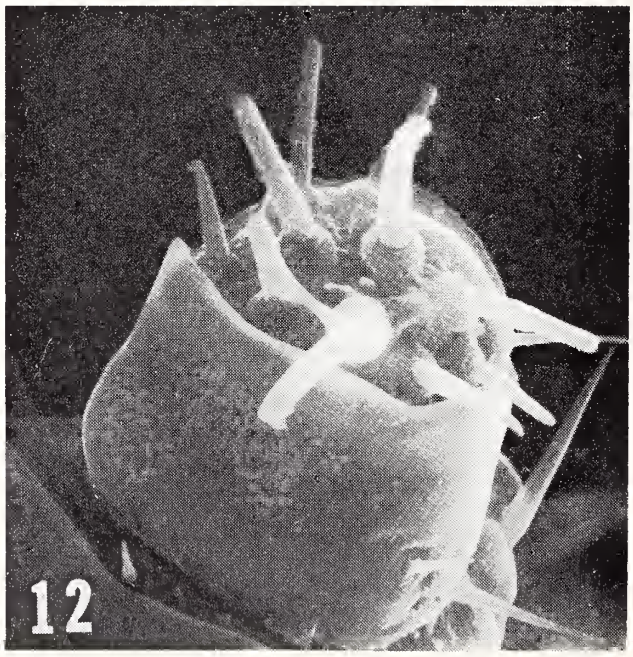
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to that seen on the first segment, but the surrounding groove is usually narrower and the sides of the dome are often irregular (Fig. 4).

The third antennal segment is the sexually dimorphic one (Figs. 5 and 6). The male segment has a distal, preaxial-angled extension which bears a tooth (Figs. 5 and 7). This tooth measures 40 to 50 microns in length by 20 to 30 microns at its base, and it tapers to a subacute point. There is a groove on the side of the tooth extending from the base to the apex. The tooth is referred to as a "spine or stout seta" by Ferris (1923), but it is obviously morphologically different from other setae seen on this species. There are usually seven setae of different sizes scattered over this segment of both males and females.

The fourth antennal segment usually has 4 or 5 setae. There is an opening on the distal, lateral aspect of this segment. This structure is similar to the sensillum coeloconicum described by Comstock (1940). A similar opening is found on the fifth, or terminal segment. The only mention Ferris (1951) makes of these structures is that they are "ring-like structures" that may be regarded as sensoria. These openings appear to be protected or partially covered by two scalloped, leaf-like plates (Fig. 8). I propose that these plates be referred to as protective plates. Within this opening a peg organ can be seen (Fig. 9) which projects from the base of the atrium. The stalk of this peg arises from a slight elevation of the floor and it is crowned by a ring of 11 rudimentary hairs. The length of the hairs are approximately equal to their width and all are the same size. The wall of the atrium is heavily sculptured and reticulate (Fig. 10). Studies of entire lice reveal similar reticulations in the respiratory atria of the spiraculae of the thorax and abdomen (Fig. 11). Studies are continuing to determine the function of the sensilla coeloconica.

The fifth or terminal segment has 3 or 4 setae scattered on its lateral walls. The opening of the sensillum on this segment is more centrally located than the one on the fourth segment. At the apex of the segment there are 11 setae-like structures of different sizes and shapes (Fig. 12). Seven are larger and blunt or obtuse at their apices, and the four centrally located ones are larger than the other three. The remaining 4 setae are located peripherally, and they are pointed. Do these differences in size and shape indicate differences in sensory functions?

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Some Pseudotyrannochthoniine False Scorpions From Western North America (Chelonethida: Chthoniidae)

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Abstract: A new species, *Pseudotyrannochthonius* **gracilis**, is described from the Pacific Northwest. *Pseudotyrannochthonius newelli* is synonymized with *P. incognitus* and the geographical range of the species is extended. Ecological data for both species are included.

Several new species of false scorpions, presently assigned to the genus *Pseudotyrannochthonius* Beier, have been described from diverse localities in the western United States in recent papers by Schuster (1966) and Muchmore (1967). Examination of the Pacific Northwest representatives of the genus in the authors' collection revealed some specimens in many ways resembling *Pseudotyrannochthonius incognitus* (Schuster), some specimens clearly identifiable as *Pseudotyrannochthonius newelli* Muchmore, a series intergrading between these two described species, and another series differing significantly from any of these groups. In an attempt to clarify the relationships, additional collections for further study were made from the western regions of Washington, Oregon, and northern California. The holotype and paratypes of *P. incognitus* (Schuster), two paratype males of *P. newelli* Muchmore, and the holotype and allotype of *P. utahensis* Muchmore were subsequently re-examined in detail.

Restudy of the holotype of *Pseudotyrannochthonius incognitus* shows that the total length, exclusive of the chelicerae, although difficult to ascertain precisely, is between 1.5 and 1.6 mm. Examination of the cheliceral fixed finger at relatively high magnification reveals that the dentition consists of a large medially-located tooth or macrodenticle preceded proximally by three, relatively distinct, tiny, marginal microdenticles which are continuous with a field of minute, acuminate tubercles or granulations at the base of the finger. The movable finger of the chela is not without teeth, as originally described, but provided with six to eight distinct, but very lightly sclerotized, low, blunt marginal teeth whose apices are basally inclined.

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Examination of the paratypic specimens of *Pseudotyrannochthonius newelli,* originally described to include two setae on the sternite of segment XI, confirms Muchmore's correction (*in litt.*) that these two setae are absent.

Based upon the above study and examination of extensive material recently collected, the authors conclude that *Pseudotyrannochthonius incognitus* and *Pseudotyrannochthonius newelli,* fall within a common range of continuous variation in morphological characteristics and are, therefore, synonymous.

The present paper includes an emended diagnosis of *P. incognitus,* a description of a new species, *P.* ***gracilis*****,** brief discussions of the ecology of the two species, and a key to the western species of the genus.

SUBORDER HETEROSPHYRONIDA CHAMBERLIN
FAMILY CHTHONIIDAE HANSEN
SUBFAMILY CHTHONIINAE HANSEN
TRIBE PSEUDOTYRANNOCHTHONIINI BEIER
GENUS *PSEUDOTYRANNOCHTHONIUS* BEIER

KEY TO ADULT FORMS OF NORTH AMERICAN SPECIES OF *PSEUDOTYRANNOCHTHONIUS*

1. Movable finger of chela with more than ten large marginal teeth; chelal length of male 1.12 mm.,[3] of female 1.35 mm.; palpal femur length of male 0.80 mm., and of female 0.91 mm. .... *utahensis* Muchmore
   Movable finger of chela with fewer than ten large marginal teeth; palpal femur and chelal length shorter than the above 2
2. Coxal spines arise individually from a lightly sclerotized or translucent hillock (Fig. 3); chelal length of male 0.98–1.04 mm., of female 1.12–1.13 mm.; palpal femur length of male 0.68–0.72 mm., of female 0.78–0.80 mm. .... **gracilis** n. sp.
   Coxal spines arise individually from a more heavily sclerotized transverse bar, or from contiguous ball-shaped pedistals—not a translucent lightly sclerotized hillock (Fig. 1); chelal length of male 0.79–0.94 mm., of female 0.89–1.11 mm.; femur length of male 0.49–0.66 mm., of female 0.59–0.76 mm. .... *incognitus* (Schuster)

Pseudotyrannochthonius incognitus (Schuster)
(Figs. 1 and 2)

Allochthonius incognitus Schuster, 1966, Pan-Pacific Ent., **42:** 172–175 (original description), p. 173, fig. 1–5 (chela, carapace, male genital area, coxal spines of pedal coxa I, intercoxal tubercle).

Pseudotyrannochthonius incognitus (Schuster), Muchmore, 1967, Trans. Amer. Microsc. Soc., **86:** no. 2, p. 134 (new combination).

Pseudotyrannochthonius newelli Muchmore, 1967, Trans. Amer. Microsc. Soc., **86:** no. 2, pp. 134–136 (original description), p. 133, fig. 1–5 (coxal spines, male palp and chela, female palp and chela).

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[3] Corrected by Muchmore (personal communication).

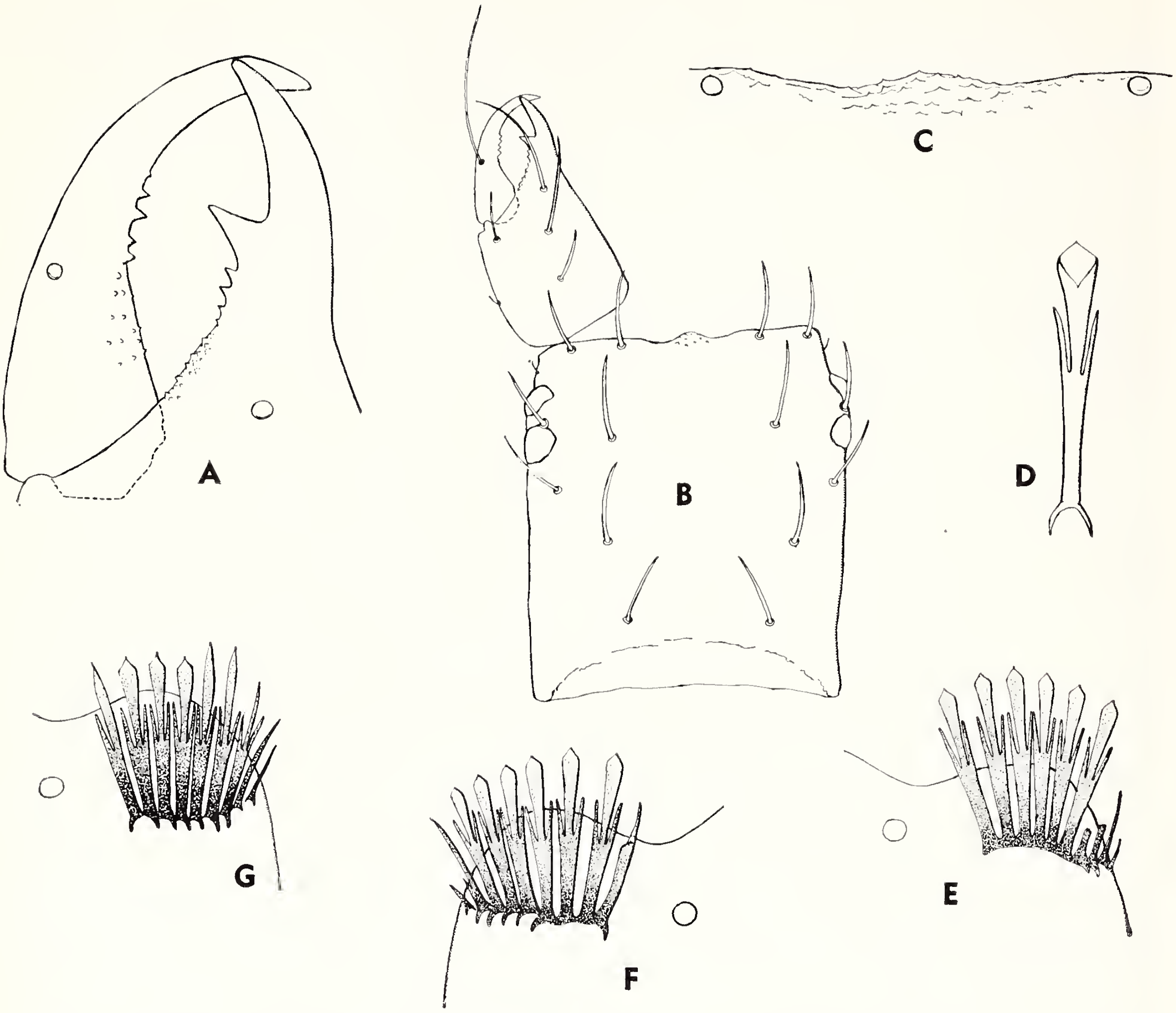

Fig. 1. *Pseudotyrannochthonius incognitus* (Schuster). Drawn from holotype male (UCD Type #225) except as indicated. Comparable structures drawn to the same scale as those in Fig. 3. A. Tip of cheliceral fingers, showing dentition grading into basal granular field. B. Carapace and left chelicera. C. Epistomal area. D. Single lateral coxal spine blade from right coxa I. E, F, G. Coxal spine series showing variability of proximal fusion of blades; E. from right coxa I (male, JC-1954.01001 [two spines broken]), F. from left coxa I (male, DM-10.04001), G. from right coxa I (Muchmore's paratype male, WM 392.02004).

As discussed above, *P. newelli* is clearly conspecific with *P. incognitus,* and thus are synonymous.

EMENDED DIAGNOSIS: Small, four-eyed species of typical generic facies, sexually dimorphic in size and chelal shape.

MALE: Carapace often constricted posteriorly; posterior margin lightly sclerotized or membranous medially; entire carapace including membranous portion longer than broad (Fig. 1B); derm reticulate; lateral and extreme anterio-medial margins delicately spinose-reticulate; epistomal process vestigial, consisting of a low, rounded elevation protruding slightly from a weak, median concavity, the anterior margin reflecting the minutely spinose carapacal derm, at most microdenticulate (Fig. 1C); four well-developed eyes, anterior pair strongly corneate and approximately one ocular diameter from anterior carapacal margin, posterior pair less developed, interocular distance one-half ocular diameter; chaetotaxy m4m-2(16).

Abdomen typical of the genus; tergal and sternal scuta entire; derm of sternites and tergites reticulate, minutely spinose laterally; pleural membrane minutely spinose; genital area typical. Range of variation in abdominal chaetotaxy as shown in Table 1; abdominal chaetotaxy of holotypic terga 2:4:4:4:6:6:6:7:5:4:2:0, of sterna 11:(4-4):$(3)\frac{4\text{-}5}{6}(3)$:(3)8(3): 12:12:11:11:7:6:0:mm.

Coxal area of typical generic facies; chaetotaxy normally 2-2-1:0-3-2-CS:2-2:2-3:2-3; apical process of coxa I broadly rounded; coxal spines comprise a transverse row of six to 10 blades arising individually from sclerotized, closely contiguous, ball-shaped pedistals which appear partially fused in some cases, each blade, except the most medial, is trifid, the apex of the central ramus acumino-spatulate and extending well beyond the lateral rami (Fig. 1D-G); intercoxal tubercle present between bases of coxae III and IV bearing two stout setae.

Chelicera (Fig. 1A, B) of typical facies, shorter than carapace and robust (1.8 to 2.2 times as long as broad); galea a very low rounded elevation to vestigial; serrula exterior of 18 to 20 blades; serrula interior of 16 to 18 blades; flagellum comprised of a biseriate row of 11 pinnate setae; fixed finger with a large median tooth and one to three microdenticles which grade into a pronounced acumino-granulate field basally; movable finger with four to six medially placed microdenticles preceded basally by a distinct granulate field; hand with small accessory seta in addition to usual *is, es, sb,* and *b* (total of five).

Palp of typical generic facies; derm of all podomeres uniformly reticulated except for distal portion of chelal fingers; vestitural setae simple acuminate. Palpal proportions: trochanter 1.4–1.8, femur 4.2–5.4, and tibia 1.9–2.2 times as long as broad; chela 4.4–5.1 times as long as broad or deep; movable finger 1.6–1.8 times as long as hand.

Chela moderately robust, heterocurvidigitate and gaping; movable finger distinctly shorter than fixed finger, apex approximating fixed finger at region of diploid setae; chaetotaxy and dentition as illustrated (Fig. 2A); fixed finger with 14 to 23 widely spaced, well-developed, acuminate teeth which become shorter and closer basally; movable finger with variable dentition, consisting of a distal series of six to eight low, blunt, poorly sclerotized, lightly pigmented, and basally inclined moderately prominent to inconspicuous marginal teeth or laminae, and a basal series of five to 12 minute, spaced microdenticles observable in the most denticulate specimens.

Legs of typical structure; derm of all podomeres distinctly reticulated; leg IV with well-differentiated tactile setae on tibia (two, with indices of 0.26–0.33 and 0.64–0.78), metatarsus (one, index of 0.23–0.33), and telotarsus (one, index of 0.23–0.36). Leg I: basifemur 4.4–5.2, telofemur 3.2–3.6, tibia 3.3–3.7, and miotarsus 7.3–8.8 times as long as deep. Leg IV: "miofemur" 2.7–3.4, tibia 4.6–5.4, metatarsus 2.6–3.4, and telotarsus 9.0–11.0 times as long as deep.

MEASUREMENTS (in mm.), MALE: body length 1.43–1.84; abdominal breadth 0.50–0.70. Carapace: median sclerotized length 0.38–0.44, ocular breadth 0.35–0.45; anterior eye diameter 0.04–0.05. Chelicera 0.31–0.38 long by 0.15–0.19 broad. Palp: trochanter 0.17–0.21 by 0.10–0.14; femur 0.49–0.66 by 0.11–0.13; tibia 0.22–0.28 by 0.11–0.14; chela 0.79–0.94 by 0.15–0.21 broad or deep; hand 0.30–0.35 long; movable finger 0.50–0.62 long. Leg I: basifemur 0.33–0.40 by 0.07–0.08; telofemur 0.21–0.26 by .06–0.08; tibia 0.16–0.21 by 0.05–0.06; miotarsus 0.35–0.44 by 0.04–0.06. Leg IV: "miofemur" 0.52–0.61 by 0.17–0.23; tibia 0.38–0.47 by 0.08–0.10; metatarsus 0.17–0.21 by 0.06–0.08; telotarsus 0.41–0.48 by 0.04–0.05.

FEMALE: In general, similar to but larger in size than male.

Genital area typical, lateral cribriform plates elongate, transverse, and often overlapping the more conspicuous median cribriform plate. Range of variation in abdominal chaetotaxy as shown in Table 1; abdominal chaetotaxy of allotypic terga 2:4:4:4:6:6:7:7:5:4:2:0; of sterna 5:(3)8(3):(3)8(3):13:12:11:10:8:6:0:mm.

Table 1. Range of variation of abdominal chaetotaxy of *Pseudotyrannochthonius incognitus* (Schuster)

	TERGITES				STERNITES			
Segment	Male	Female	Trito-nymph	Deuto-nymph	Male	Female	Trito-nymph	Deuto-nymph
I	2	2	2	2	7 to 12	4 to 8	4	2
II	2 to 4	4	4	4	(4-4)			
III	4	4	4	4	(3)5 to 6-4 to 7(3) 6 to 8	(3)7 to 10(2 to 3)	(2)5 to 6(2)	(1)2(1)
IV	4 to 5	4 to 5	4	4	(2 to 3)6 to 9(2 to 3)	(3)6 to 9(2 to 3)	(2)6(2)	(1)4(1)
V	6	5 to 6	6	6	12 to 14	11 to 16	9 to 11	6
VI	6 to 7	6 to 7	6	6	10 to 13	11 to 13	9 to 10	6
VII	6 to 7	6 to 7	5 to 7	7	9 to 12	10 to 13	8 to 10	7
VIII	6 to 8	6 to 7	7	6	7 to 11	8 to 11	7 to 10	7
IX	4 to 5	4 to 5	5	5	6 to 9	7 to 9	5 to 7	7
X	3 to 5	4 to 5	4 to 5	4	5 to 7	5 to 7	4 to 6	5
XI	2	2	2	2	0[1]	0	0	0
XII	0	0	0	0	mm	mm	mm	mm

[1] The report of two setae on sternite XI in the original description of *P. newelli* (Muchmore, 1967, p. 135) is in error; the number is actually 0.

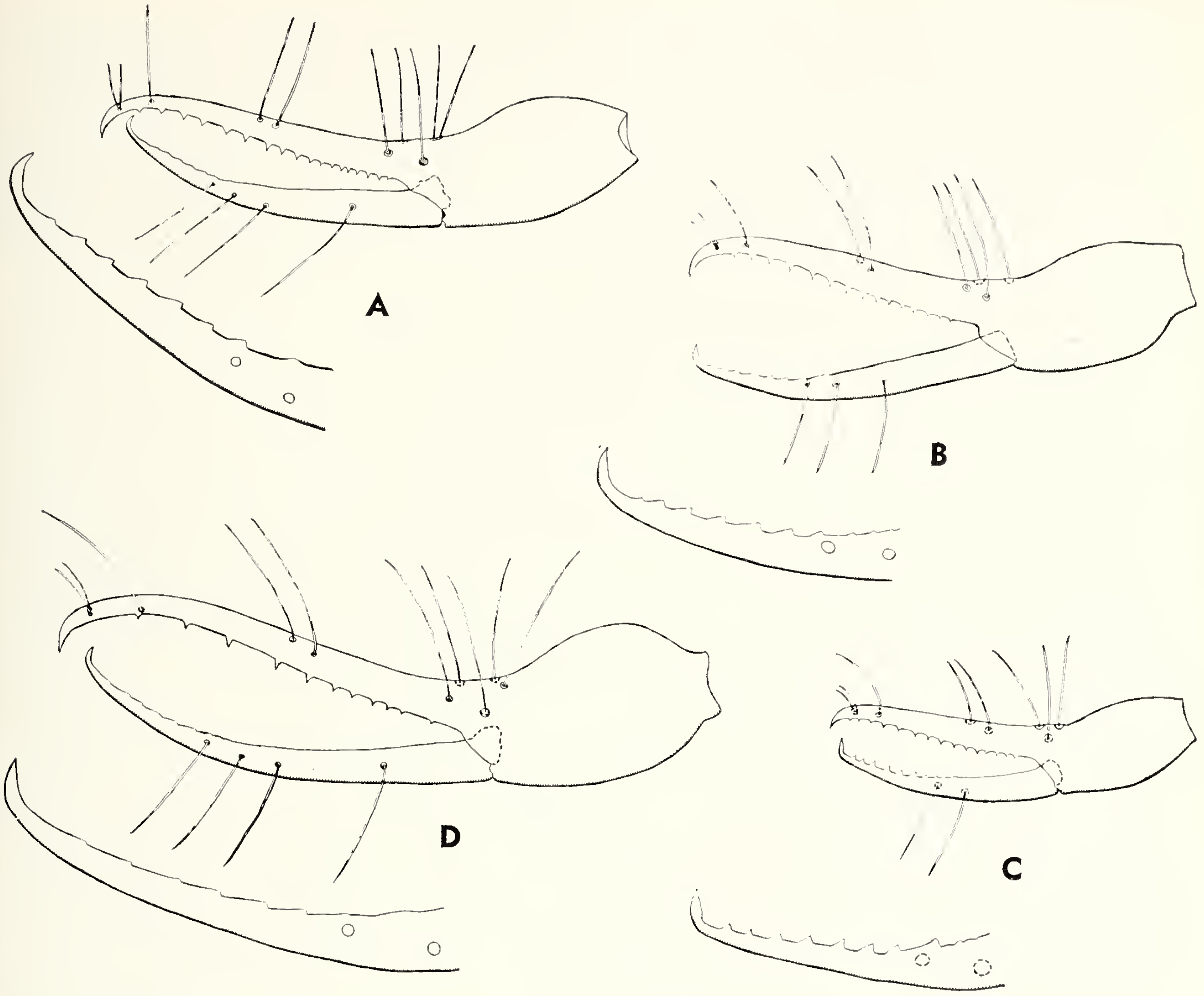

Fig. 2. *Pseudotyrannochthonius incognitus* (Schuster). Comparable structures drawn to the same scale as those in Fig. 3. A. External aspect of left chela of male (holotype, UCD Type #225). B. External aspect of left chela of tritonymph (JC-1412.02001). C. Internal aspect of right chela of deutonymph (JC-1412.02002). D. External aspect of left chela of female (JC-1931.02001).

Palp, except for chela, similar to male; chela markedly sexually dimorphic, hand not only larger but tending to be broader and deeper in proportion to the length (Fig. 2D); fixed finger with 11 to 20 spaced well-developed teeth similar in form and spacing to male; dentition of movable finger similar to male except less prominent, consisting of a distal series of six to eight low, blunt and poorly sclerotized teeth and a basal series of as few as one or two to six or seven extremely minute microdenticles, visible only under high magnification and in favorably oriented specimens; movable finger always meeting fixed finger proximal to diploid setae. Palpal proportions: trochanter 1.5–1.7, femur 4.5–5.4, and tibia 1.9–2.1 times as long as broad; chela 3.8–4.4 times as long as broad or deep; movable finger 1.6–1.8 times as long as hand.

Leg IV with well-differentiated tactile setae on tibia (two, with indices of 0.26–0.31 and 0.66–0.70), metatarsus (one, index of 0.24–0.36) and telotarsus (one, index of 0.23–0.33). Leg I: basifemur 4.5–5.1, telofemur 3.0–3.7, tibia 3.1–3.4, and miotarsus 7.6–8.9 times as long as deep. Leg IV: "miofemur" 2.8–3.5, tibia 4.3–5.5, metatarsus 2.6–3.1, and telotarsus 8.9–10.0 times as long as deep.

MEASUREMENTS (in mm.), FEMALE: body length 1.67–2.21; abdominal breadth 0.59–0.84. Carapace: median sclerotized length 0.41–0.50, ocular breadth 0.45–0.57; anterior eye diameter 0.04–0.05. Chelicera 0.38–0.47 long by 0.19–0.23 broad. Palp: trochanter 0.20–0.25 by 0.12–0.15; femur 0.59–0.76 by 0.13–0.15; tibia 0.27–0.32 by 0.14–0.15; chela 0.89–1.11 by 0.22–0.27 broad or deep; hand 0.32–0.40 long; movable finger 0.59–0.71 long. Leg I: basifemur 0.37–0.46 by 0.08–0.10; telofemur 0.23–0.29 by 0.07–0.09; tibia 0.18–0.23 by 0.06–0.07; miotarsus 0.40–0.50 by 0.05–0.06. Leg IV: "miofemur" 0.55–0.68 by 0.18–0.22; tibia 0.41–0.52 by 0.08–0.11; metatarsus 0.18–0.24 by 0.07–0.08; telotarsus 0.42–0.53 by 0.05–0.06.

TRITONYMPH: Much like adult in general conformation but lighter in color and smaller in size.

Carapacal and dorsal abdominal chaetotaxy similar to adult, ventral chaetotaxy not as extensively developed both on abdominal sternites (Table 1) and on coxae (2-2-1:0-3-1-CS: 2-2:2-2:2-2); coxal spines similar morphologically but fewer in number (usually six trifid and one medial simple blade); intercoxal tubercle present; cheliceral chaetotaxy as in adult.

Three tactile setae on movable finger of chela (SB, ST, T) and seven on fixed finger of chela (Fig. 2B); dentition of chelal fingers typical of species but more conspicuous on movable finger than in adult; fixed finger with 15–20 macrodenticles, movable finger with variable dentition, a total of approximately 18 "teeth" in the most denticulate specimens consisting of a distal series of seven to 10 blunt, poorly sclerotized, lightly pigmented, and basally inclined prominent marginal teeth, and a basal series of nine to 11 minute, spaced microdenticles. Palpal proportions: trochanter 1.5–1.7, femur 4.3–4.8, and tibia 1.9–2.1 times as long as broad; chela 4.1–4.7 times as long as broad or deep; movable finger 1.6–1.8 times as long as hand.

Legs of typical structure; leg IV with tactile setae on tibia (two, with indices of 0.26–0.34 and 0.63–0.69), metatarsus (one, index of 0.23–0.31), and telotarsus (one, index of 0.23–0.31). Leg I: basifemur 3.8–4.5, telofemur 2.8–3.2, tibia 2.7–3.3, and miotarsus 6.3–7.2 times as long as deep. Leg IV: "miofemur" 2.7–3.2, tibia 4.2–4.9, metatarsus 2.2–2.8, and telotarsus 7.4–8.3 times as long as deep.

MEASUREMENTS (in mm.), TRITONYMPH: body length 1.16–1.35; abdominal breadth 0.32–0.54. Carapace: median sclerotized length 0.34–0.38, ocular breadth 0.26–0.38; anterior eye diameter 0.04. Chelicera 0.30–0.32 long by 0.15–0.16 broad. Palp: trochanter 0.16–0.18 by 0.09–0.12; femur 0.44–0.52 by 0.10–0.11; tibia 0.20–0.23 by 0.11–0.12; chela 0.62–0.75 by 0.14–0.17 broad or deep; hand 0.24–0.28 long; movable finger 0.39–0.50 long. Leg I: basifemur 0.27–0.32 by 0.06–0.08; telofemur 0.17–0.20 by 0.06–0.07; tibia 0.13–0.17 by 0.05; miotarsus 0.29–0.35 by 0.05. Leg IV: "miofemur" 0.38–0.46 by 0.14–0.16; tibia 0.29–0.35 by 0.07–0.08; metatarsus 0.13–0.16 by 0.05–0.07; telotarsus 0.31–0.37 by 0.04–0.05.

DEUTONYMPH: (Based on specimen JC-1412.02002). Similar to adult but much smaller, paler, derm less well-sclerotized, eyes less well-developed.

Carapace and dorsal abdominal chaetotaxy similar to adult, chaetotaxy of ventral surface not as extensively developed as adult or tritonymph both on abdominal sternites (Table 1) and on coxae (2-2-1:0-2-0-CS:2-1:2-1:2-1); coxal spines of typical adult configurations but with fewer blades (five trifid and one simple medial blade); bisetose intercoxal tubercle present; hand of chelicera with one less seta than adult or tritonymph (*b* missing).

Movable finger of chela with two tactile setae, fixed finger with six tactile setae (Fig. 2C); chelal dentition, especially of movable finger, more prominent than either adult or tritonymph, fixed finger with 16 spaced macrodenticles, movable finger with seven conspicuous teeth preceded basally by three reduced and less distinct denticles. Palpal proportions: trochanter 1.5, femur 3.8, and tibia 1.8 times as long as broad; chela 4.2 times as long as broad or deep; movable finger 1.7 times as long as hand.

Legs typical of species; leg IV with differentiated tactile setae on tibia (two, with indices of 0.25 and 0.64), metatarsus (one, index of 0.23), and telotarsus (one, index of 0.17). Leg I:

basifemur 3.4, telofemur 2.3, tibia 2.5, and miotarsus 6.4 times as long as deep. Leg IV: "miofemur" 2.9, tibia 3.9, metatarsus 2.2, and telotarsus 5.8 times as long as deep.

MEASUREMENTS (in mm.), DEUTONYMPH: body length approximately 0.91; abdominal breadth approximately 0.30. Carapace: median sclerotized length 0.29; ocular breadth 0.29; anterior eye diameter 0.03. Chelicera 0.23 long by 0.12 broad. Palp: trochanter 0.13 by 0.08; femur 0.34 by 0.09; tibia 0.16 by 0.09; chela 0.51 by 0.12 broad or deep; hand 0.20 long; movable finger 0.34 long. Leg I: basifemur 0.20 by 0.06; telofemur 0.12 by 0.05; tibia 0.11 by 0.05; miotarsus 0.24 by 0.04. Leg IV: "miofemur" 0.31 by 0.11; tibia 0.23 by 0.06; metatarsus 0.10 by 0.05; telotarsus 0.26 by 0.05.

ECOLOGY: The authors' fieldwork supports Schuster's observation (1966) that *Pseudotyrannochthonius incognitus* is "widespread and rarely collected." Populations of the species appear to be highly localized as indicated by the erratic recovery of specimens from seemingly suitable microhabitats; generally, population levels have been found to be low.

The species, though never abundant, is widely distributed in the lowland (sea level to approximately 2,000 ft. elev.) humid Transition Life Zone west of the Cascade Mountains of the Pacific Northwest, from at least Skamania County, Washington, south to Humboldt County, California. Schuster records a tritonymph from Idaho. Throughout its distribution, the species is typically associated with leaf litter, soil, and decomposing wood from beneath such dominant deciduous species as: *Acer macrophyllum* Pursh, *A. circinatum* Pursh, *Alnus rubra* Bong., or *Quercus* (Tourn.) L. spp. Frequently the above species are associated in second growth timber with at least one of the following conifers: *Pseudotsuga menziesii* (Mirb.) France, *Tsuga heterophylla* (Raf.) Sarg., *Thuja plicata* Donn., or *Picea sitchensis* (Bong.) Carr. Samples of coniferous litter unmixed with deciduous components, or duff of pure *Quercus*, or of *Populus trichocarpa* T. and G. or of *Populus tremuloides* Michx., though yielding other chthoniids, have proven unproductive of *Pseudotyrannochthonius incognitus*.

Hoff (1959, p. 58) found in New Mexico that "interspecies competition is so great that pseudoscorpions of related species and genera are seldom taken in the same collection." This rigorous inter-generic competition does not appear to be exhibited in the soil-humus inhabiting genera of Chthoniidae in the Pacific Northwest. Representatives of at least one other chthoniid genus were found in all but one of the 39 collections of *P. incognitus* belonging to the authors. Most frequently the genus *Apochthonius* Chamberlin is associated, but often *Mundochthonius* Chamberlin, and sometimes *Kleptochthonius* Chamberlin, are collected with *Pseudotyrannochthonius*.

Collection data for 137 specimens from 46 separate collections made over a span of years were pooled and analyzed by month. With the exception of a single deutonymph, the only nymphal forms recovered to date have been tritonymphs. Although field searches were fairly evenly distributed throughout the year, nymphs have been collected only from midsummer to late autumn (July–November). Adults have been recovered during all months of the year; however, both sexes were collected in greatest number during the winter and spring (November–April), the population reaching a peak in December. Despite nearly equal frequencies of males and females found in midwinter, the widely disparate sex ratios observed during summer produce an overall sex ratio of approximately twice as many males as females collected. This preliminary analysis suggests that detailed investigation of the life history of the species and of annual densities in natural populations would be fruitful. Adequate verification of population dynamics, however, is contingent upon the refinement of specialized statistical field techniques suitable for the study of chthoniids.

TYPE RECORDS:

California. Humboldt County: 18.0 miles south of Klamath (Del Norte County), 13 August 1953, two tritonymphs.

Idaho. Shoshone County: Jct. Nicolas Creek and Coeur d'Alene River, 29 July 1959, one tritonymph.

Oregon. Douglas County: Loon Lake, 30 June 1959, one male [UCD Type #225, holotype of *Allochthonius incognitus* (Schuster 1966, p. 174) = *Pseudotyrannochthonius incognitus* (Muchmore 1967, p. 134)]; 1.1 mile east of Scottsberg, 2 July 1959, one male. Washington County: 2.0 miles south of Timber, 1 December 1948, four males and one female [WM 392.02002 allotype of *Pseudotyrannochthonius newelli* (Muchmore 1967, p. 134), hereby designated as allotype of *P. incognitus*].

NEW RECORDS:

California. Huhboldt County: Dry Lagoon State Park, 114.0 miles north of county line, 22 March 1967, one male.

Oregon. Benton County: 6 miles west of Greenberry, 3 March 1937, two males and two females; state highway 34, Benton County Line, 15 September 1960, two males. Clackamas County: 1.5 miles east of Beaver Creek, 4 February 1967, one female; approximately 4 miles north of Sandy, 30 December 1967, one male and seven females; approximately 4 miles north and 1 mile west of Sandy, 30 December 1967, one male. Coos County: Marine Institute of Biology, Charleston, 13 August 1956, one male, 30 April 1967, one male. Curry County: 2 miles south of Denmark, 27 April 1937, two males; Humbug Mountain State Park, 6 miles south of Port Orford, 15 September 1960, three tritonymphs; 1.5 miles south of Nesika Beach, 29 January 1967, seven males and one female; 4.5 miles south of Gold Beach, 30 January 1967, two males. Douglas County: 19 miles north of Wolf Creek, 6 April 1937, one male; Cottage Grove, 18 April 1937, one male; Canyon Creek, November 1937, one female. Lane County: Walton, 1 December 1957, two males and five females; 6 miles north of Noti, 15 September 1960, one tritonymph; 2 miles west of Noti, 15 September 1960, five tritonymphs. Lincoln County: Five Rivers (Alsea River), 13 March 1937, two females; 7.7 miles northwest of Eddyville, 20 June 1966; two males and one female. Linn County: 5 to 6 miles east of Mill City, September 1941, one deutonymph and one tritonymph. Marion County: Fern Ridge Road, Mill Creek between Stayton and Mehama, 28 September 1941, one male and two tritonymphs; 4 miles southwest of Silver Falls State Park, 5 March 1967, two males; 10 miles southwest of Silverton on state highway 214, 5 March 1967, three males. Multnomah County: Section Line Road, 4 miles east of Gresham, 15 July 1967, three nymphs, 30 December 1967, nine males; Oneonta Trail, near Oneonta Falls, 33 miles east of Portland, November 1967, one male. Tillamook County: Tierra Del Mar, 6 March 1955, one male; Cape Lookout State Park, 12 miles southwest of Tillamook, 29 August 1966, three tritonymphs, 9 April 1967, one male; 10.5 miles east of Tillamook, 13 November 1966, one female; Camp West Wind, 4.5 miles north of Otis Junction, one female. Washington County: "Government Lot," Forest Grove, 18–24 April 1941, one male and one female; Timber, 19 April 1941, two males; 2 miles west of Forest Grove, 15–16 April 1942, two males; 4 miles west and 3 miles north of Forest Grove, 30 October 1966, six tritonymphs, 26 November 1966, four males, one female and one tritonymph, 18 December 1966, seven males and eight females; Bishop Road, 2 miles north of Helvetia, 1 November 1966, two males and two females, 21 January 1968, two males and one female.

Washington. Skamania County: 0.9 miles due north from USGS Gaging Station on Lewis River of Swift Res., 21 June 1966, one male and one female.

Pseudotyrannochthonius **gracilis** n. sp.
(Fig. 3)

DIAGNOSIS: Relatively small, four-eyed species with facies typical of the genus; sexually dimorphic in size, and chelal shape; derm reticulated throughout. In life, specimens are delicate in appearance, with pale tan, almost transparent legs; light tan palps; chelicerae tan with reddish-brown fingers; greenish-gray carapace and tergites.

MALE: (Holotype followed by paratypic variation in parentheses). Carapace constricted caudally; posterior margin lightly sclerotized medially; entire carapace, including membranous portion, longer than ocular breadth; heavily reticulate derm obviously spinose laterally and lightly spinose anteriorly; epistomal process vestigial, consisting of a low, rounded elevation protruding only partially from a median concavity, anterior margin microdenticulate (Fig. 3C); four well-developed eyes, anterior pair strongly corneate and located approximately one and one-half ocular diameters from anterior carapacal margin, posterior pair less developed, interocular distance one-quarter ocular diameter or less; chaetotaxy m4m-2(16).

Structure of abdomen typical; tergal and sternal scuta entire and obviously minutely spinose laterally; pleural membrane minutely spinose; male genitalia typical. Abdominal chaetotaxy of terga 2:4:4:4:6:6:7:7:5:4:2:0, of sterna 11:(4-4):(3)$\frac{5\text{-}5}{10}$(3):(3)8(3):13:12:11:10:7:6:0:mm. [range of male types 9 to 12:(4-4):(2 to 3)$\frac{4\text{-}4 \text{ to } 6}{8 \text{ to } 13}$(3):(3)6 to 8(3):11 to 14:11 to 13:10 to 11:9 to 11:7 to 8:6 to 8:0:mm.].

Coxal area of typical generic facies; chaetotaxy normally 2-2-1:0-3-2-CS:2-2:2-3:2-3; apical process of coxa I broadly rounded and non-setose; a total of eight or nine coxal spines on each coxa I in a transverse series of eight (six to nine) trifid and one (or two) simple medial blades which arise from a lightly sclerotized or translucent hillock, the central ramus of each blade sharply acumino-spatulate and extending beyond the lateral rami (Fig. 3F); intercoxal tubercle with two stout setae.

Chelicera (Fig. 3C, D, E) typical of the genus, shorter than carapace and robust (2.2 [1.9–2.2]) times as long as broad; galea a low, rounded elevation to vestigial; serrula exterior of approximately 20 blades; serrula interior of 16 to 17 blades; flagellum a biseriate row normally of 11 pinnate setae; fixed finger with a large median tooth and one to two smaller marginal denticles which grade into a very prominent acumino-granulate field basally; movable finger with five to eight medially placed marginal microdenticles which generally

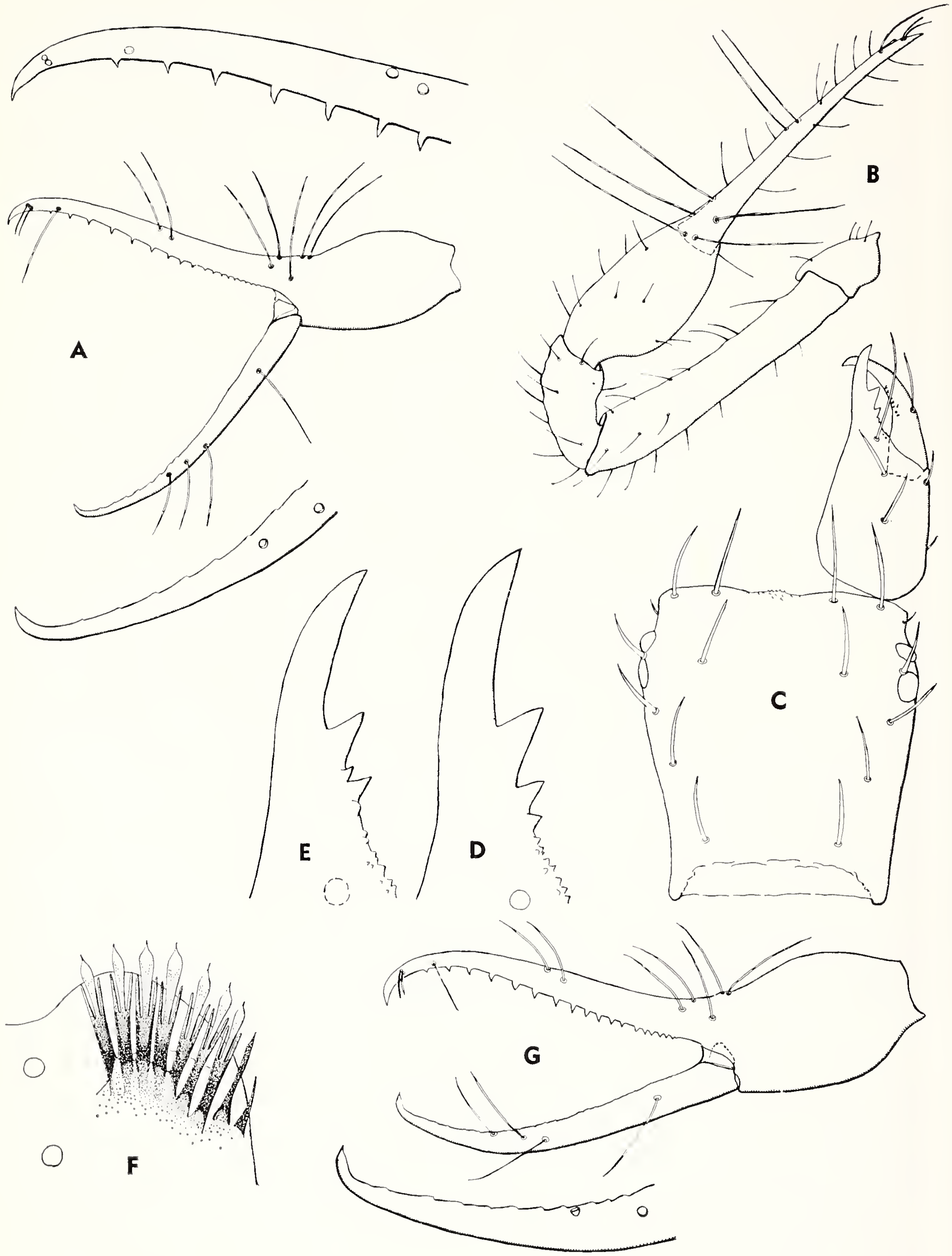

Fig. 3. *Pseudotyrannochthonius* **gracilis** n. sp. Comparable structures drawn to the same scale as those in Figs. 1 and 2. A. External aspect of left chela of male (JC-1967.02001). B. Dorsal aspect of left palp of male (DM-366.01001). C. Carapace and right chelicera (holotype male). D, E. Variable dentition of cheliceral fixed finger; D. holotype male, E. male (DM-366.01002). F. Coxal spine series from right coxa I (male, JC-1967.02001). G. External aspect of left chela of female (allotype).

intergrade with a basal granular field; hand normally with one small accessory seta in addition to *is, es, sb, b* (total of five).

Palp (Fig. 3B) of typical generic facies; derm of podomeres reticulate; vestitural setae simple acuminate. Palpal proportions: trochanter indeterm. (1.7), femur 5.2(5.1–5.6), and tibia 2.1(2.1–2.2) times as long as broad; chela 4.7(4.7–5.1) times as long as broad or deep; movable finger 1.7(1.6–1.7) times as long as hand.

Chela moderately robust; fingers curved and gaping; movable finger distinctly shorter than fixed finger and meeting it proximal to the diploid setae; chaetotaxy and dentition as illustrated (Fig. 3A); fixed finger with 22(16–22) well-developed acuminate teeth which become smaller and closer together basally; movable finger superficially "toothless" but under high magnification seen to bear a distal series of approximately six (six to eight) very lightly sclerotized and poorly pigmented low, basally-inclined, elongate laminae and a basal series of three to seven extremely minute, spaced microdenticles.

Legs of typical structure; derm of all podomeres distinctly reticulated; leg IV with well-differentiated tactile setae on tibia (two, with indices of 0.30[0.26–0.32] and 0.66[0.65–0.68]), metatarsus (one, index of 0.28[0.25–0.30]), and telotarsus (one, index of 0.32[0.25–0.33]). Leg I: basifemur 4.7(4.7–5.0), telofemur 3.9(3.6–3.9), tibia 3.7(3.4–3.7), and miotarsus 8.5 (8.5–8.7) times as long as deep. Leg IV: "miofemur" 3.3(3.0–3.3), tibia 5.2(4.9–5.4), metatarsus 3.1(2.9–3.1), and telotarsus 9.8(9.2–9.8) times as long as deep.

MEASUREMENTS (in mm.), MALE (holotype and range for all male types): body length 1.85(1.73–1.85); abdominal breadth 0.68(0.54–0.68). Carapace: median sclerotized length 0.46(0.44–0.48), ocular breadth 0.48(0.39–0.48); anterior eye diameter 0.05(0.04–0.05). Chelicera 0.43(0.38–0.43) long by 0.20(0.18–0.20) broad. Palp: trochanter indeterm. (0.22-indeterm.); femur 0.72(0.68–0.72) by 0.14(0.13–0.14); tibia 0.30(0.26–0.30) by 0.14(0.13–0.14); chela 1.04(0.98–1.04) by 0.23(0.19–0.23) broad or deep; hand 0.39(0.36–0.39) long; movable finger 0.65(0.62–0.65) long. Leg I: basifemur 0.40(0.38–0.41) by 0.09(0.08–0.09); telofemur 0.27(0.26–0.27) by 0.08(0.07–0.08); tibia 0.22(0.20–0.22) by 0.06(0.05–0.06); miotarsus 0.48(0.45–0.48) by 0.06(0.05–0.06). Leg IV: "miofemur" 0.65(0.62–0.65) by 0.20 (0.20–0.22); tibia 0.50(0.47–0.50) by 0.10(0.09–0.10); metatarsus 0.23(0.22–0.23) by 0.08 (0.08); telotarsus 0.51(0.48–0.51) by 0.05(0.05).

FEMALE: (Allotype followed by paratypic variation in parentheses): Very similar to male but larger.

Genital area of typical facies. Abdominal chaetotaxy of allotypic terga 2:4:4:4:6:6:7:7:5:4:2:0, of allotypic sterna 8:(3)10(3):(3)8(3):12:12:11:9:7:6:0:mm.

Palp except for chela similar to male; chela sexually dimorphic, hand not only larger but markedly broader and deeper in proportion to length (Fig. 3G); teeth of both fingers similar to male in form and spacing, fixed finger with 17–20 well-developed teeth and movable finger with six to eight poorly developed teeth; tip of movable finger always meeting fixed finger proximal to diploid setae. Palpal proportions: trochanter 1.6, femur 5.1(5.1–5.5), and tibia 2.1(2.1–2.2) times as long as broad; chela 4.1(4.0–4.4) times as long as broad or deep; movable finger 1.8(1.8–1.9) times as long as hand.

Leg IV with well-differentiated tactile setae on tibia (two, with indices of 0.29[0.26–0.29] and 0.65[0.65–0.67]), metatarsus (one, index of 0.28[0.26–0.29]), and telotarsus (one, index of 0.30[0.30–0.32]). Leg I: basifemur 5.0(4.9–5.2), telofemur 3.5(3.5–3.8), tibia 3.7(3.3–3.7), and miotarsus 8.3(8.3–8.7) times as long as deep. Leg. IV: "miofemur" 3.2(3.2–3.4), tibia 5.0(5.1–5.4), metatarsus 3.1(3.1–3.3), and telotarsus 10.3(10.3–10.8) times as long as deep.

MEASUREMENTS (in mm.), FEMALE (allotype and range for all female types): body length 1.89(1.89–2.43); abdominal breadth 0.72(0.68–0.78). Carapace: median sclerotized length 0.50(0.49–0.51), ocular breadth 0.52(0.45–0.52); anterior eye diameter 0.05(0.04–0.05). Chelicera 0.49(0.45–0.50) long by 0.23(0.21–0.23) broad. Palp: trochanter 0.26 by 0.16 (range indeterm.); femur 0.78(0.77–0.78) by 0.15(0.14–0.16); tibia 0.33(0.32–0.35) by 0.16(0.14–0.16); chela 1.13(1.12–1.13) by 0.28(0.26–0.28) broad or deep; hand 0.42(0.39–0.42) long; movable finger 0.73(0.71–0.74) long. Leg I: basifemur 0.45(0.44–0.46) by 0.09(0.09); telofemur 0.29(0.28–0.30) by 0.08(0.08); tibia 0.25(0.22–0.25) by 0.07(0.06–0.07); miotarsus 0.50(0.47–0.50) by 0.06(0.06). Leg IV: "miofemur" 0.71(0.71) by 0.22(0.20–0.22); tibia 0.53(0.53–0.54) by 0.11(0.10–0.11); metatarsus 0.26(0.25–0.26) by 0.08(0.08–0.09); telotarsus 0.54(0.53–0.54) by 0.05(0.05).

REMARKS: This species appears to exhibit an unusually high frequency of intraspecific variation in several morphological characters. For example, the large marginal denticles of the cheliceral fixed finger exhibit great variation, both between right and left chelicerae on a single specimen, and between individuals (Fig. 3D, E). The species also shows frequent doubling or deletion of setae. All but one of the paratypes show one or more deviations from the "normal" chaetotaxy of the carapace, chelicerae, coxal area, or abdomen. Examples of variation from the usual pattern of chaetotaxy are as follows: one specimen showing loss on the carapace of one anterior marginal seta, resulting in a distribution of m3m-2(15); four specimens with two accessory setae on the hand of the right chelicera and a single accessory seta on the hand of the left chelicera; three specimens with a doubling or loss of setae on a single coxa only (1 or 2-2-1: 0-3 or 4-2-CS:2-1 or 2:2-3:2-3); and four specimens with doubled setae on several abdominal tergites or sternites.

ECOLOGY: Despite extensive collecting efforts made throughout the year from west central Washington southward into California, this new species has been found only during the winter months of November through February at extremely low population levels in the lowlands near Puget Sound in Washington and near the Smith River in northern California. Unlike *Pseudotyrannochthonius incognitus,* this species appears to be associated with either moss or coniferous duff rather than with deciduous debris. *Pseudotsuga menziesii* (Mirb.) (in Washington) and *Sequoia sempervirens* Endl. (in California), with no significant associated deciduous species, were the dominant trees at the successful collection sites. Although most specimens have been recovered from a dense groundcover of moss or duff with no shrub layer present, some specimens have been collected from beneath an almost impenetrable broad-leaf evergreen shrub layer of *Vaccinium ovatum* Pursh and *Gaultheria shallon* Pursh under second-growth *P. menziesii.* Berlese extraction of a large number of collections from the type localities and adjacent areas made over a period of two years, although yielding several hundred chthoniids in all stages of development, produced only 10 adult specimens of *Pseudotyrannochthonius* **gracilis.** Representatives of the genera *Kleptochthonius, Apochthonius, Mundochthonius,* and *Microcreagris* Balzan are abundantly present at the type locality.

RECORDS: (all specimens collected by authors except as noted).

California. Del Norte County: along Smith River, near Crescent City, 9 November 1956, Vestres and Schuh collectors, one paratype male (DM-90.01001).

Washington. Mason County: 2.0 miles south and 0.5 miles west of Grapeview, 25 November 1967, one paratype male (DM-352.01001), 21 January 1968, two paratype females (DM-363.01001, DM-363.01002); 1.5 miles south and 0.5 miles west of Grapeview, 21 January 1968, two paratype males (DM-366.01001, DM-366.01002); 2.5 miles north of Grant, 21 January 1968, paratypes, one female and one male (DM-365.01001, DM-365.01002). Thurston County: Puget, 11 February 1932, W. W. Baker collector, one paratype male (JC-1967.02001), 27 December 1966, male holotype (DM-236.01001) and female allotype (DM-237.01001).

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Malaise Trap Studies of Flying Insects in a New York Mesic Forest
I. Ordinal Composition and Seasonal Abundance

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Abstract: Continuous Malaise trap collections at four sampling stations yielded 40,348 individuals over 13 weeks in summer 1967. Greatest numbers of insects were collected in early June, fewest in late July. Diptera comprised 44.7% of the catch, followed by Plecoptera (20.8%), Hymenoptera (14.7%), Lepidoptera (7.2%), Hemiptera (7.1%), Coleoptera (2.4%) and other orders (3.1%). The majority of Diptera were Nematocera; in contrast to other reports, mosquitoes and Tabanidae were seldom collected. The unusual abundance of Plecoptera was due almost exclusively to one species, *Nemoura albidipennis* Walker, which swamped collections of one trap during the first four study weeks. Thirty-five families of Hymenoptera exclusive of the Chalcidoidea were taken, Ichneumonidae and Tenthredinidae being most abundant. Lepidoptera were almost exclusively moths, those less than 3.0 mm in body length comprising 49–69%. Cicadellidae and Cercopidae accounted for nearly all of the Hemiptera taken. Seasonal occurrence patterns of selected taxa are discussed.

Most field-oriented entomologists have intuitive feelings about diversity and seasonal change in insect communities. But there are few quantitative data, and virtually nothing is known about long term change and insect succession in a given habitat. In hope of providing a basis for such studies, this report, and others to follow, presents analyses of continuous Malaise trap collections taken between 2 June and 31 August, 1967. The present paper compares data in terms of total numbers of adult individuals; subsequent papers will analyze species diversity, sex ratios, size classes, and trophic relationships.

METHODS

This study was conducted at the Edmund Niles Huyck Preserve, Inc., a biological field station and wildlife preserve of over 1100 acres bordering Rensselaerville, New York, on the Helderberg Plateau about 22 miles southwest of Albany. Centered about two bodies of water (9.4 acre Lincoln Pond and 94 acre Lake Myosotis) formed by the damming of Ten-Mile Creek, the Preserve varies in elevation from 1400 to 1700 ft. above sea level; nearby hills range up to 2200 ft. Most of the land is forested, varying from natural white pine and mature hemlock-beech stands to planted spruce and red pine. Two factors

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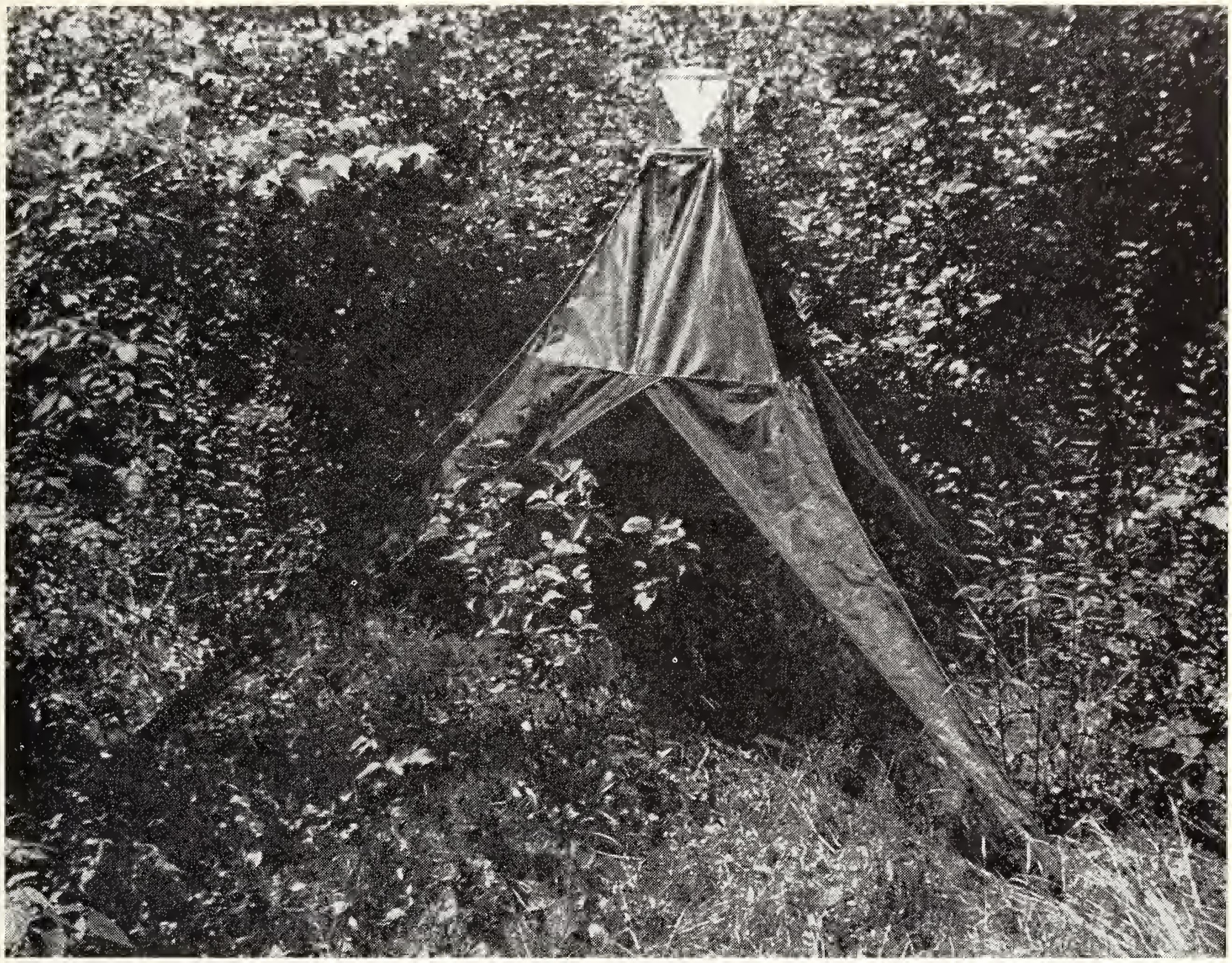

Fig. 1. Cornell-type Malaise trap used in this study. Height to top of globe, 1.7 m; base length, center pole to corner stake, 1.2 m; base distance between stakes, 2 m.

make the E. N. Huyck Preserve particularly appropriate and pleasing for this study: its protection from disturbance since about 1900, and its subjection to annual biological field research since 1939. These conditions have resulted in a well known flora (see, for example, Odum, 1943; Russell, 1955, 1958) and the possibility of long term follow-up studies on diversity and succession.

Three commercially available Malaise traps[1] were used (Fig. 1). These were unmodified; hence, future investigators will have the option of using the same types of traps to obtain comparative data in different habitats and geographical areas. Two of the gray-green traps were left in their original location for the entire 13 week period of study; the third was moved at the end of the fourth week to a new location. Vegetation around the traps was clipped back twice during the summer to permit complete access to all sides of the traps. Trap localities and vegetational components of the immediate habitat are listed in Table 1.

Seventy per cent ethyl alcohol was the killing agent. Traps were emptied

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[1] Manufactured by the Cornell Equipment Co., Inc., 1115 N. Rolling Rd., Baltimore, Md. 21228.

Table 1. Malaise trap localities and selected vegetational components of immediate habitat.

Trap No.	Specific Location	Herbaceous Cover	Understory	Canopy	Exposure	Moisture Source
1	SW edge, Trout Pond clearing	Adventive grasses, rushes & sedges; *Impatiens*, *Hypericum*, *Lysimachia*, *Solidago*	*Prunus*, *Alnus*, *Rubus*, *Salix*, *Viburnum*	upstream: *Acer*, *Fraxinus*, *Ostrya*, *Picea glauca*[1]	full sun most of day	Adjacent inlet dry by mid-July; standing water in pond throughout summer
2	SE corner, Lincoln Pond, 30 m E. of dam, 40 m N. of Pond Hill Rd.	grasses; *Fragaria*, *Potentilla*, *Polygonatum*, *Aster*	*Prunus*, *Alnus*, *Rubus*	*Fraxinus americana*	partly exposed	Adjacent vernal spring dry by early July
3	100 m E. of Lincoln Pond	mosses; *Oxalis*	very sparse and open	*Tsuga canadensis*	dense shade	In an active stream draw over moss-covered rocks
4	Power line transect W. of Trout Pond, 15–20 m S. of Pond Hill Rd.	low grasses, mosses & lichens; *Solidago*	saplings of *Fraxinus*, *Populus*, & *Acer*	*Picea glauca*[1]	full sun most of day	Only trap not in proximity to water

[1] Planted, 1924

daily between 0930 and 1030, and collections sorted to order for each trap; spiders, worker ants and immature holometabolous insects were disregarded. All specimens, labelled to indicate the Malaise trap from which they were taken, are deposited in the Museum of Comparative Zoology, the U.S. National Museum, and the authors' personal collection.

CLIMATIC CONDITIONS AND SEASONALITY

Two general patterns are evident when variations in insect numbers in combined Malaise trap catches are examined. Daily weather—particularly temperature and precipitation—exercised a strong influence upon the catch size, largest catches occurring on hot, sunny days following rain. In our relatively sheltered sites, wind was not an important variable, though it could greatly affect trap performance in exposed situations. When weekly collections are considered, however, the effect of short term weather conditions becomes less obvious, and certain seasonality patterns emerge. As Fig. 2 indicates, the greatest numbers of insects were captured in the early weeks of summer. Mid-summer proved least productive in terms of total insect abundance, and although numbers increased slightly in August, they remained well below the June levels for most groups. The early season abundance in the Malaise traps seems most reasonably attributed to a combination of factors. The synchronization imposed on insect development by the changing seasons and the appearance of vernal foliage fresh for oviposition and larval growth would naturally lead one to postulate early summer to be the period of greatest total adult insect activity. In addition, many insects cruise just above the herbaceous vegetation, which in early spring

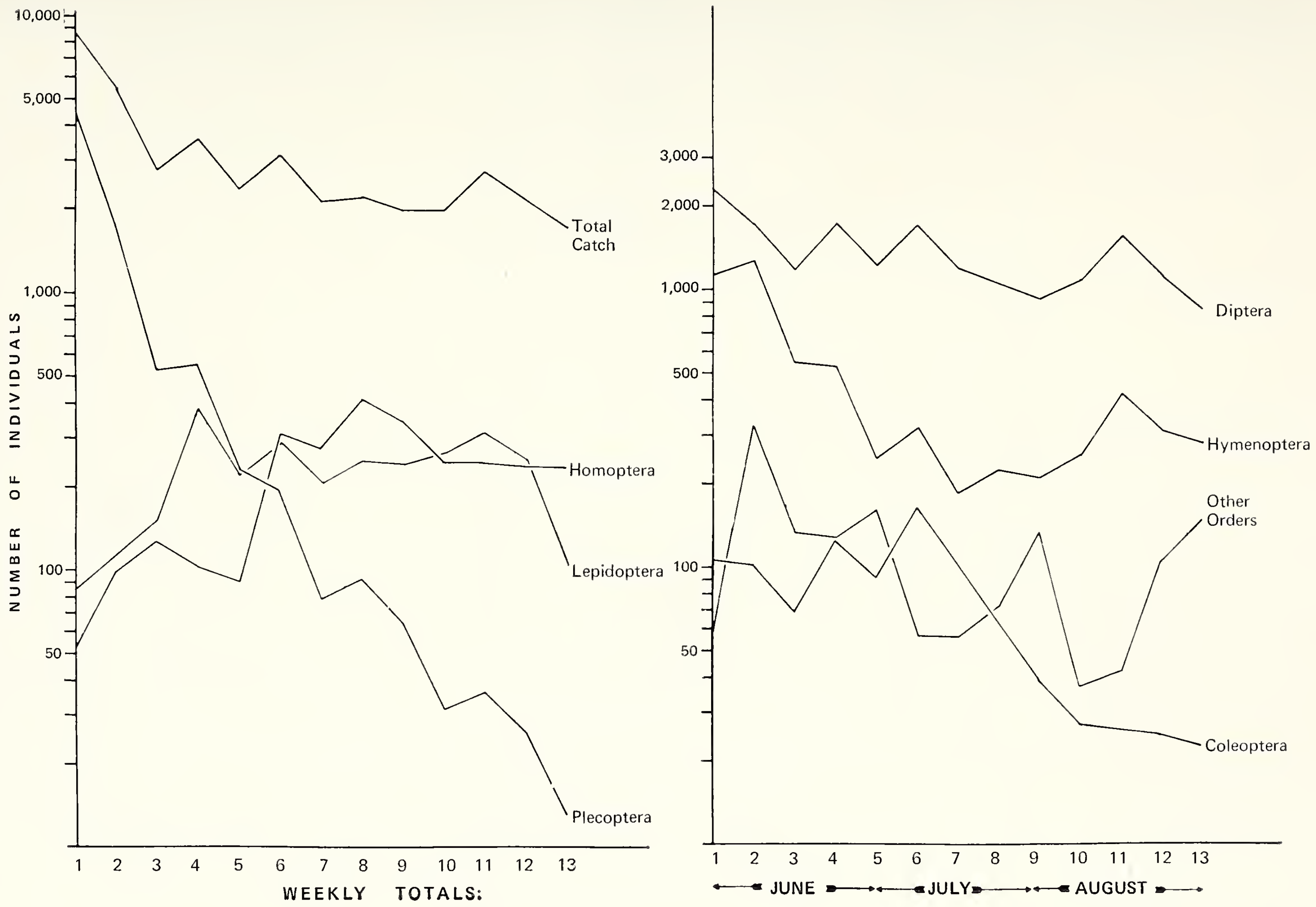

Fig. 2. Seasonal abundance by order of combined Malaise trap collections from the E. N. Huyck Preserve, New York, during the summer of 1967. Week 1 is June 2–8, and week 13, August 25–31.

Table 2. Selected summer weather data for Albany, New York, about 22 mi. NE, and about 1,000 ft. lower in elevation, than the E. N. Huyck Preserve. Data furnished by the Albany County Soil and Water Conservation District, based on records of the U.S. Weather Bureau from the Albany Airport.

	June	July	August	September
Average temperature (°C.)	19.6	22.3	21.0	16.4
Mean maximum temperature (°C.)	25.8	28.7	27.4	22.6
Mean minimum temperature (°C.)	13.3	15.8	14.6	10.1
Average rainfall (mm)	84.1	89.4	86.9	99.7
Average per cent sunshine	61%	63%	62%	58%
Average relative humidity at 1:30 p.m.	56%	54%	56%	60%

would be at the most favorable height for funneling them into the trap openings. Furthermore, as Townes (1962) points out, insects tend to fly lower earlier in the season because the warmest air is near the ground. A Malaise trap study of seasonal changes in insect traffic at different heights above the ground would no doubt provide valuable insights.

In order for others to be able to compare our data more meaningfully with future Malaise trap studies, some climatological data are given in Table 2. At Albany, New York, the closest weather station to the Huyck Preserve, the average date of the last killing frost in the spring is May 20, and the first killing frost, September 27; at the approximately 1,000 ft. higher elevation of the Preserve, these dates are undoubtedly somewhat later and earlier, respectively. Temperatures at the Preserve generally averaged 3–5 degrees cooler than at Albany.

TRAP PLACEMENT

As is obvious from Table 3, quantity and diversity of insects obtained was greatly influenced by trap placement. Trap 1, the most productive, averaged 259 insects per day (range, 36–749)—considerably more than the others combined, and 59% of the entire summer collections; it also obtained the greatest number of taxa. These results were not unexpected, for this was by far the most ecologically varied of the sampling stations. Moreover, Trap 1 was situated between pond and forest and at the mouth of a stream, the combined effect of which was to funnel the insects into the trap's vicinity. Finally, the fact that the trap was in full sun for most of the day no doubt enhanced its efficiency. For when a trap of this type is exposed to full sunlight, the temperature within the collecting globe soon becomes much higher than the surrounding air,[2] and the combination of heat and alcohol fumes quickly causes entering insects to succumb.

Trap 3 obtained the least diversity, but held the record for the most insects caught in one day (901 on June 5, of which 817 were a single stonefly species).

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[2] For example, on a representative clear day, the ambient air temperature breast high in the shade at 1300 was 24.5°C; inside the undisturbed globe of Trap 1 it was 39.5°C.

Table 3. Malaise trap catch: total seasonal composition by insect order (arranged in decreasing percentages of total for all traps combined). Asterisks represent values of less than 0.05%.

Order	Trap 1	Trap 2	Trap 3	Trap 4	Combined Traps
Diptera	52.2%	43.1%	14.7%	54.4%	44.5%
Plecoptera	8.3	16.8	76.9	0.3	20.8
Hymenoptera	16.9	22.5	1.2	13.0	14.7
Lepidoptera	7.1	10.0	0.8	15.5	7.2
Homoptera	9.1	3.8	*	10.6	6.9
Coleoptera	3.1	2.0	0.3	2.6	2.4
Collembola	1.7	1.2	0.7	0.6	1.4
Thysanoptera	*	*	4.9	0.1	0.9
Trichoptera	1.1	0.1	0.5	*	0.7
Heteroptera	0.3	0.1	*	0.3	0.2
Psocoptera	0.1	*	*	1.3	0.2
Neuroptera	0.1	*		*	0.1
Odonata	0.1	*		0.1	*
Mecoptera	*	*			*
Ephemeroptera	*	*	*		*
Orthoptera	*				*
Total Numbers (N)	23,722	6,138	7,008	3,480	40,348
Trap-Weeks in Operation	13	13	4	8	38
Inclusive Dates	2 June–31 Aug.	2 June–31 Aug.	3–30 June	7 July–31 Aug.	

Omitting the Plecoptera, Trap 3 compared poorly, netting a catch of about 16% as much as Trap 1 during the first month of operation. For this reason, Trap 3 was discontinued on June 30, and the following week was begun as Trap 4 in a new location. There, despite the drier and superficially more monotonous surroundings, its catch was enhanced by a natural insect flyway created by the power line transect, and exceeded that of Trap 2 in both numbers and diversity.

ORDINAL COMPOSITION

During the 13 weeks of study, the three traps collected 40,348 insects representing 16 orders. As can be seen from Table 3 and Figure 2, six orders (Diptera, Plecoptera, Hymenoptera, Lepidoptera, Hemiptera, and Coleoptera) accounted for over 95% of this total. If correction is made in Trap 3 for two species (a plecopteran and a thrips) which swamped (81.8%) the collections at that site, then Diptera were most abundant (52.2–80.4%) in all traps, while Hymenoptera averaged a distant (6.3–22.5%) second.

A few orders consistently appeared differentially in certain traps (*e.g.*, Plecoptera in Trap 3). The majority, however, especially those in which many species with diverse environmental relations were represented, showed no definite intertrap patterns when the weekly collections from the four traps were analyzed separately. Therefore, to facilitate discussion, weekly samples from the traps have for the most part been combined here.

DIPTERA: Diptera comprised 45% of all individuals collected, the majority being nematocerous flies; midges, gall and fungus gnats were extremely abundant. Simuliidae were taken in large numbers in early summer. However, mosquitoes, while obviously common in the vicinity of the traps, were seldom caught—despite reports (Smith *et al.*, 1965; Breeland and Pickard, 1965; Gunstream and Chew, 1967) extolling the virtues of the Malaise trap as a tool for mosquito collections and survey. Likewise, only 9 individuals of Tabanidae were taken, although common at the Preserve and well represented in other workers' Malaise trap collections. In Surinam Malaise samples, for example, horse flies comprised nearly 10% of the total catch (Geijskes, 1968). Perhaps some aspect of the Cornell-type trap construction is the critical factor; most previous studies have utilized traps based upon the Townes model (Townes, 1962).

HYMENOPTERA: Ichneumonoidea, Symphyta, Chalcidoidea and Apoidea comprised the bulk (90.3%) of the Hymenoptera collected. Ichneumonidae and Tenthredinidae were the most common families; the 33 (excluding Chalcidoidea) other families collected included several not commonly encountered, *e.g.*, Heloridae, Gasteruptiidae, Sapygidae, Dryinidae, Platygasteridae and Melittidae. Trap 1, as usual, obtained the greatest quantity and diversity (67% of all Hymenoptera, including over 30 families).

Symphyta were most abundant early in the season and, in fact, had already peaked before the trapping was begun; in mid-August they exhibited a second but smaller increase in numbers. Interestingly, the Ichneumonoidea, although parasites of a diverse range of insects, paralleled both of these peaks almost exactly. Apoidea also were most frequently encountered in early season. In contrast, the predatory Pompiloidea were most abundant in mid-season. The remaining groups were taken in low and relatively constant numbers throughout the summer.

LEPIDOPTERA: Our Malaise traps collected almost exclusively moths, the bodies of over half (49–69%) measuring less than 3.0 mm excluding antennae. These latter "microlepidoptera" showed two sudden flushes in numbers—the first, during the last week of June, marking the first and best defined faunal transition of the summer. The second, and smaller, peak occurred the first week of August. Both of these population flushes were followed, with about a two week time lag, by peaks in numbers of larger Lepidoptera.

HEMIPTERA: Over the entire season, adults of six families of Homoptera were collected—Cicadellidae (52.8%), Cercopidae (32.7%), Psyllidae (8.3%), Aphididae (3.0%), Membracidae (2.3%), and Fulgoridae *sensu latu* (0.8%). At least four of these were quite markedly seasonal: the Psyllidae reaching their greatest numbers by late June, the Cercopidae and Cicadellidae rapidly peaking during the month of July, and the Fulgoridae appearing only in small numbers during late July and August.

Comprising only 0.2% of the total, Heteroptera were but a minor element;

most (70%) were Miridae, with occasional Neididae and Pentatomidae, no aquatic representatives being present in the Malaise collections.

COLEOPTERA: Numbers of Coleoptera peaked the week of July 7–13, when they comprised 5.3% of the catch. But overall, beetles were less common in the Malaise trap collections than one might initially expect, presumably because they usually drop upon encountering obstacles. Most abundant were Chrysomelidae, Curculionidae and Cantharidae; no aquatic Coleoptera were obtained, despite the proximity of water to three sites.

OTHER ORDERS: Because of the striking seasonal flush of *Nemoura albidipennis* Walker,[3] the Plecoptera were by far the most frequently collected aquatic group. However, discounting this one species, the aquatic orders were perhaps most conspicuous by their small numbers or absence. For example, occasional Chloroperlidae and a single Pteronarcidae taken were clearly not representative of the plecopteran fauna of the Preserve; Ephemeroptera and Trichoptera likewise were obtained only in very small numbers, although many individuals and species were collected by sweeping and light traps. The few Odonata collected were all Coenagrionidae.

A number of the smaller terrestrial orders were also sparsely represented. The few Mecoptera belonged to the Panorpidae. Except for two Hemerobiidae and one Coniopterygidae, the Neuroptera were represented only by Chrysopidae. The Thysanoptera and Psocoptera await further identifications, but 335 of 346 thrips collected in Trap 4 represented a single species collected 15–17 June. The relatively large numbers of Collembola, even in the drier Trap 4, is striking, since they are normally associated with moist litter; however, the majority were taken on rainy days, when the traps were thoroughly wet.

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Notes on a Migration of *Urania fulgens* (Lepidoptera: Uraniidae) in Costa Rica[1]

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Abstract: Daily records were kept on the numbers of individuals of the tropical, day-flying moth *Urania fulgens* (Uraniidae–Heterocera) migrating on a large scale as seen at three different localities located in the central part of Costa Rica. Less regular observations made at several other localities indicated that the migration was a widespread phenomenon in Costa Rica. This migration of *Urania*, studied from its very early phase and on through its termination, lasted from 12 August to 24 September 1969 and was carefully studied for 30 of these 42 days. On the basis of the 54,625 moths counted using one method of sampling the migrating population, flight activity pattern on a daily basis was found to be bimodal. The peaks of most flight activity (largest numbers of moths flying) were equal and these occurred between 7:00 to 11:00 AM and between 3:00 and 6:00 PM (C. S. T.) with very few moths flying between 11:00 AM and 3:00 PM. Samples of several hundred netted individuals taken at various times over the course of the migration, revealed that sex ratio in the population was always unity and with females carrying large numbers of eggs. That the migrating population was composed of young adults was indicated by the fresh appearance of these moths; an assay was conducted to estimate life expectancy and for males, it was 28 days and for females, 34 days. Traffic rate, speed, and density of the migration were estimated to describe the consistency of the population on a day-to-day basis. A brief discussion is given concerning ecological experimental approaches that could be used to study insect migrations in general.

INTRODUCTION

The purpose of this brief communiqué is to call attention to a fast-moving, large scale migration of a tropical uraniid moth, *Urania fulgens* (Uraniidae—Heterocera) that occurred over a six-week period in the central part (at least) of Costa Rica. This particular species of day-flying moth is abundant from southern Mexico to northern South America. Large scale migration of *U. leilus* have been reported for Trinidad and British Guiana and have been noted as taking place at varying intensities year-to-year and usually between July and

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October for a given year (Kirkpatrick, 1957). Beebe and Fleming (1951) records that *U. leilus* migrations, large or small, were seen 13 times in 3 years at one locality in North-Central Venezuela. Valerio (1966) observed a migration of *U. fulgens*, "La Colipato Verde," in Costa Rica during 1964 and reported that this migration occurred from July and on through August and the first week of September; the migration was flying south. He noted that this migration passed over several different, widely-spaced localities and adds that very little is known about these migrations in general. Similar observations on this species in Costa Rica have been made before (Williams, 1930). Migrations of *U. fulgens* have also been seen near Veracruz, Mexico, along the Atlantic coast of Honduras, in Nicaragua and Panama, and near Bogota, Colombia (Biologia Centrali—Americana, Vol. **2**, 1891–1900). Aside from these spurious observations, very little is indeed known about the factors underlying these impressive migrations, points of origins and destinations, specific migratory routes, day-to-day consistency of the migration, and activities of adults along migratory routes (e.g., mating, deposition of eggs, death rates of adults from predation and other sources, and interactions of adults with other organisms). Costa Rica is a small country (1300 sq. miles) that possesses an extensive north–south rugged mountain range that essentially divides the land into Atlantic and Pacific lowland areas. Migration in *U. fulgens* in Costa Rica may simply involve "extensive local movements" across mountains from east (Atlantic) to west (Pacific) lowland areas (Dr. Thomas C. Emmel, personal communication). This paper presents some new data on migration in *U. fulgens* (hereafter referred to as *Urania*) and discusses some possibilities for future studies of this insect that pertain to general ecological theory.

MATERIALS AND METHODS

From 12 August through 24 September 1969, a migration of *Urania* was observed in Costa Rica; prior to the former data (and for 10 successive months) and after the latter date, the moths were not seen anywhere. During this period (42 days) large numbers of *Urania* were seen flying southeast daily as observed at three different localities. These localities were as follows: (1) about 2 miles north of the city of San José which is situated near the base of mountains (9° 56′ N; San José Province; elev. 4,500 feet; premontane moist forest region); observations made in an open pasture that abutted on El Coco International Airport; (2) along a strip of paved road leading into a small village, Puerto Viejo (10° 26′ N; Heredia Province; elev. 200 feet; premontane wet forest region) located about 40 miles east of San José; (3) at Finca La Selva (hereafter termed La Selva; tropical wet forest region), a biological research station located one mile south of Puerto Viejo and abutting on the Rio Puerto Viejo. And from frequent traveling along the single road that connects Puerto Viejo with San José, it was apparent that the migration was very widespread as moths were seen flying in very large numbers all along this route. On 11 August and in San José, I noticed only a few *Urania* in the general vicinity. This observation prompted me to attempt censusing the migrating population on a regular basis. Also, I recalled that from 13 September through 17 September of the previous year (1968), I had noticed large numbers of *Urania* at the Osa Peninsula region (Rincon de Osa, Puntarenas Province; elev. 105 feet; tropical wet forest region; about 125 miles south of San José) of Costa Rica. For the present study, I was therefore able to begin censusing at about the time when the migration had actually begun to pass over the localities mentioned above. Most likely, the beginning and termination dates of these migrations vary from year to year since the 1964 migration had lasted from July through September (as reported by Valerio, 1966).

For each month and at each of the three localities, I recorded the numbers of individuals passing by and overhead (moths flew anywhere from 2 to 80 feet above the ground) for 5 successive days, and from 6:00 AM to 6:00 PM (C. S. T.) daily. Thus there were a total of 30 days of censusing involving three independent sets (replicates) of observations. The moths usually flew in loose formations of anywhere from 5 to 27 individuals and due to the large wingspan (about 4 inches) of this species, in conjunction with the easily-recognized diagnostic black-and-irridescent green stripe pattern of the swallowtail-shaped wings (resembling some members of the Papilionidae such as *Papilio philenor*), it was a simple matter to count accurately the numbers of individuals passing over predetermined censusing points. At each locality, censusing "points" had been previously established by selecting two large trees that were about 50 feet apart and that had a clear back drop view of sky between them (as seen from ground level). The migrating population was then "sampled" by counting the numbers of moths passing between the marker trees.

Aside from securing these basic data, records were also kept on weather (rainfall and wind) and various parameters characteristic of a migrating animal population were calculated and these will be described below.

RESULTS AND DISCUSSION

EVIDENCE OF MIGRATION. That this was indeed a study of an insect migration was indicated by these observations: (1) large numbers of the moths were flying in close proximity and all in the same general direction in the presence and absence of wind and rain; (2) the moths flew for more than 40 days in this manner; (3) flight behavior of the moths did not typically include periods of exploration of the many nectaries in bloom at the localities studied (e.g., there was reduced feeding); (4) copulating pairs of moths and subsequent oviposition behavior were not observed; (5) for 10 months prior to this migration, I had not seen this species as a regular inhabitant in any of several localities of Costa Rica. Several of these observations clearly fall into agreement with Williams

(1930) and also with the recently-proposed definition of migration in insects given by Kennedy (1961): "a persistent, straightened-out movement that is accompanied by and dependent upon the maintenance of an internal inhibition of those 'vegetative' reflexes (e.g., delays in feeding and reproduction—my enclosure) that will eventually arrest movement." And as diapause in insects allows for escape in time from prevailing environmental conditions, migration achieves the same result in space (Slobodkin, 1961).

As checked at 2-mile intervals along the 40-mile road from Puerto Viejo to San José at different times during this study, this migration was evident in equal intensities all along this route. This suggests that the migration was evident from the Atlantic coast to the central mountain of Costa Rica but unfortunately, no comparable data were obtained for the area between the mountains and the Pacific coast. It is of the opinion of Valerio (1966) that the 1964 migration took the form of three distinct, widely-spaced routes down through Costa Rica: (1) down the Pacific coast, (2) through the central, mountainous region, and (3) down the Atlantic coast. For regions in between these routes, very few moths were seen. In the 1969 migration studied here, it is apparent that the migration differed from the 1964 migration of *Urania* in at least one way, namely, that the region between the central mountains and Atlantic coast constituted one large migration route since moths appeared in similar high densities throughout this region (as seen along one "transect" dilineated by the road between Puerto Viejo (very close to the Atlantic coast) and San José. Several persons have informed me that the moth was present in large numbers at Limon, a city located along the Atlantic coast. Perhaps this difference between the two years reflects differences in the size of the migrating population; a less productive population may establish separate parallel routes (i.e., spread out to a greater extent) while a large population would have one continuous wide route. For a small narrow country such as Costa Rica bounded on opposite sides by sea, this might be a necessity since if a very large population were to spread out, many individuals would be subject to the high risk of perishing at sea.

THE MIGRATING POPULATION. From time to time over the 30-day study period, samples of flying moths were netted at each locality, and based on these catches (a total of 516 individuals were caught), it was found that the migration was composed of equal numbers of males and females and all were *fulgens*. Other species of *Urania* did not appear in this migration. Furthermore, 80% of the females caught had greatly distended and widened abdomens that were found, upon dissection, to be filled with a mean number of 118 ± 5.6 (S. D.) eggs per female. Sex ratio and the fecund condition of females did not change with time —samples netted at different times during the migration revealed no significant differences. Also, all adults captured were fresh (newly emerged); further observations with high-powered binoculars of flying moths revealed that practically all individuals had their entire wings in tact including the long tails of the hind wings. That apparently most of the adults were in good condition suggests that the migrating population was composed of young adults. Dingle (1968) in a laboratory study concerning effects of various environmental and biotic factors upon migration tendency in the milkweed bug, *Oncopeltus fasciatus,* found that this insect (a seasonal migrant) exhibits most of its long duration flight activity when adults are 8 to 10 days old (i.e., when very young).

An attempt was made to estimate the life expectancy of migrating *Urania* adults. Into each of 100 mosquito netting bags (15 inches wide by 25 inches tall) one newly captured adult was gently placed (after determining sex), each bag then labeled with sex of adult and date, and then all bags were hung in a shady spot at La Selva, where this assay was carried out. There was a total of 45 males and 55 females thus kept and from time to time (and once a day) a sugar water solution was sprayed on 25 of the female replicates and on 25 of the male replicates (i.e., half of the 100 individuals were given a food source and one-half were deprived of it). Not all replicates were begun on the same day but over a two-day period. For each replicate (a moth in its cage) a daily check was made (at 4 different times per day) to determine if the moth was alive and active. From this assay, mean life expectancy for males was 28 ± 3.4 (S. D.) days and for females, it was 34 ± 2.5 days. A standard *t* test was used for comparing mean differences in numbers of individuals dying in the fed and non-fed groups. In the fed group, adults were actually observed to feed on the sugar water drops clinging to the netting and this feeding could enhance age-specific mortality. It was assumed that age-specific deaths in all groups were approximately normally distributed and the *t* test is robust against minor deviations from normality. There was no significant differences in life expectancy between fed and non-fed moths of either sex ($P > 0.05$) which indicated that feeding did not enhance age-specific longevity of adults. Most likely, migrating adults rely heavily upon reserve nutrient storage products for energy and only occasionally feed during migration and perhaps primarily for moisture. Of course, these values of life expectancy are under estimates of the true values since adults were obviously alive for a certain length of time when captured; furthermore, nothing is known about the precise age-distribution in the migrating population. Females live a significantly longer time than males (as indicated by a *t* test). Just what fraction of life span is devoted to migration and what fraction is devoted to the sedentary phase of life needs to be determined for *Urania.*

FLIGHT ACTIVITY PATTERNS. From the 30 days of censusing, it was possible to detect diurnal variations in the numbers of adults flying daily. These data are summarized in Fig. 1. These results are based on a total of 54,625 moths counted (17,615 at San José; 21,682 at Puerto Viejo; 15,328 at La Selva) and the main point emerging from the data is that flight activity was bimodal in its intensity:

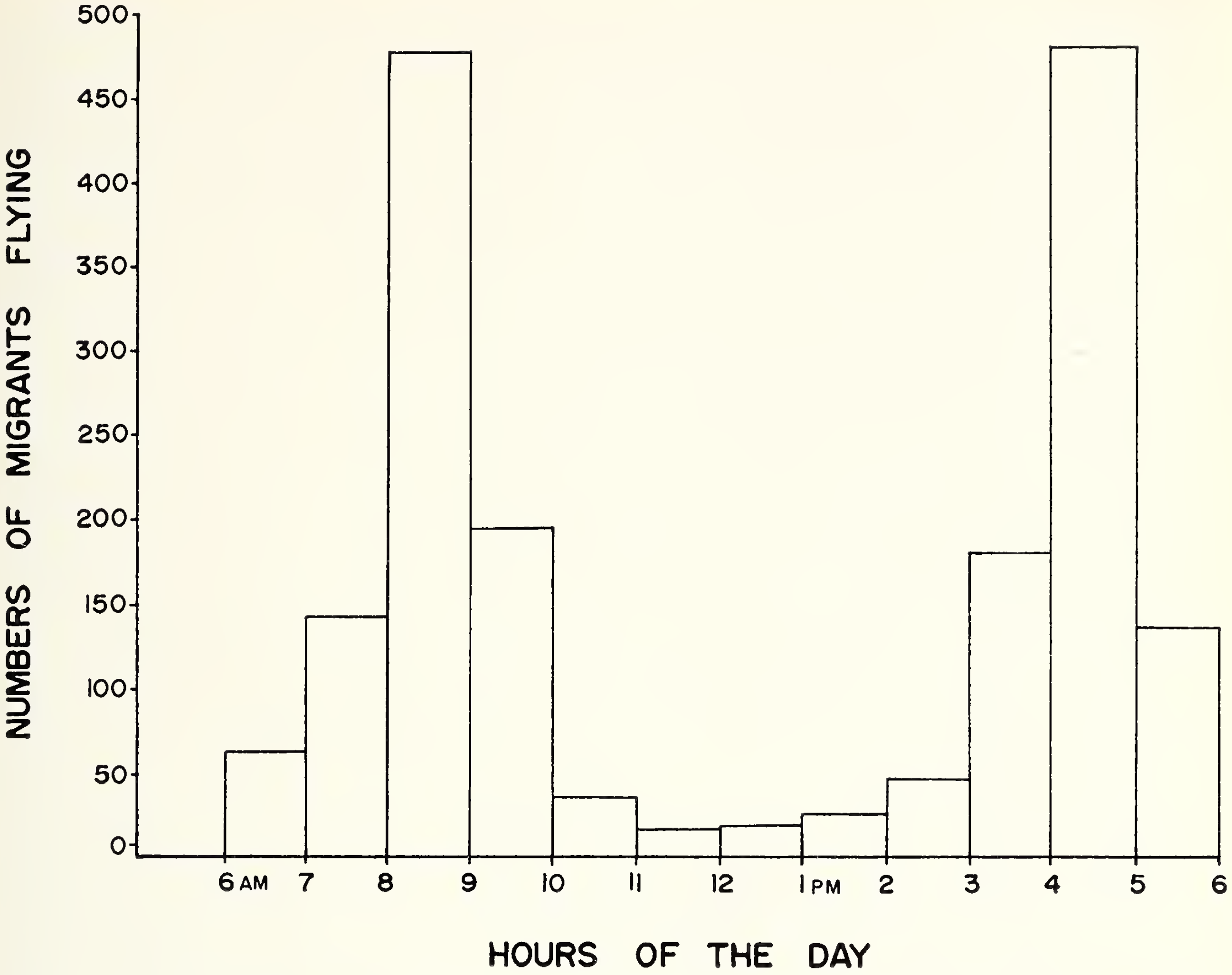

Fig. 1. The daily flight activity pattern during a migration of the tropical, day-flying moth *Urania fulgens* in Costa Rica. Each vertical bar in the histogram represents a mean of 30 days of observation, pooling the data obtained at 3 different localities. Flight activity was bimodal in daily pattern; most individuals flying from 7:00 to 11:00 AM and from 3:00 to 6:00 PM (C.S.T.). Very few moths flew during the hours between these periods and none flew at night.

the majority of moths flew between 7:00 and 11:00 AM and between 3:00 and 6:00 PM daily; very few moths flew from 11:00 AM to 3:00 PM (Fig. 1). Moths did not fly from 6:00 PM to 6:00 AM. Valerio (1966) reports that *Urania* flies all day during migration but did not discuss any bimodality in daily flight activity. The bimodality in flight activity seen in the present study was evident regardless of prevailing local weather conditions; *Urania* was equally active on both hot, sunny days and cool, overcast days, and in the same manner hourly. Moreover, days of light, persistent rainfall did not hamper flight activity at any locality; only on those days when rainfall was very heavy and accompanied by strong winds was flight activity of migrating *Urania* curtailed. There were only four such days (widely scattered) during the 42 days of the migration and these were not included as days of observation. It is not clear as to why flight activity was bimodal; perhaps a cessation of this activity during the hottest hours (10:30 AM to 2:00 PM) of the tropical day at these localities helped to conserve the stored fat products and other substances that are undoubtedly needed for long range migrations. Dingle (1968) found, under laboratory conditions, that an increase in ambient temperature decreased the proportion of individuals migrating in an *Oncopeltus* population. This is interpreted as a means of delaying reproduction in the population and allowing more time for the insect to migrate from its unfavorable habitat (in the field) and reproduce elsewhere. Similarly, for a tropical migrant insect such as *Urania,* there may be a day-to-day physiological necessity to diminish flying when ambient temperatures are highest during the day. Records on daily temperature for the past 12 months at La Selva indicate that between 10:30 AM and 3:00 PM, air temperature is usually 2.5°C higher than at other times during the day (A.M.Y., personal observations). At La Selva, observations on daily activities in a large population of the butterfly *Anartia fatima* (Nymphalidae—Nymphalinae) revealed that this very abundant species is appreciably less active after 11:00 AM and on through midafternoon (A.M.Y., personal communication).

During the period of decreased flight activity, many moths were seen perching on the leaves and branches of large trees and only occasionally would a few individuals rest on plants near the ground. *Urania* was never seen to visit flowers of herbaceous plants and vines. However, at La Selva, the large canopy tree *Inga* sp. (Mimosaceae) was in bloom during September (from the 6th and on through October) and these small, clustered white flowers were frequently visited by many individuals of *Urania* during the period of decreased flight activity. *Urania* may play an important role as a pollinator of this insect-pollinated tree. In general, very little is known about effects of migrating Lepidoptera as pollinators of various plants located along their migratory routes and the problem certainly warrants attention. It is doubtful that *Inga* was an important food source for migrating *Urania,* in light of what has been already discussed on this subject. In the laboratory, the milkweed bug *Oncopeltus* exhibited enhanced flight activity when starved over short periods of time (Dingle, 1968). During the night, *Urania* rests in large trees and are occasionally attracted to nearby lights.

Fig. 2 shows the temporal census history behavior of the migrating population. As censuses of the moths could not be made simultaneously at all three localities, I was not aware of exactly when *Urania* had initially appeared at Puerto Viejo until six days after witnessing their initial appearance at San José. However, conversing with several local residents of Puerto Viejo revealed that probably the migration had not begun to pass through this area more than one week earlier. This indicated that *Urania* probably appeared at about the same time in all three localities. Beyond the initial 4 days of the migration and prior to the final 3 days of it, about the same numbers of moths passed over censusing points each day (about 1,900 moths per day considering the three localities as one large sample).

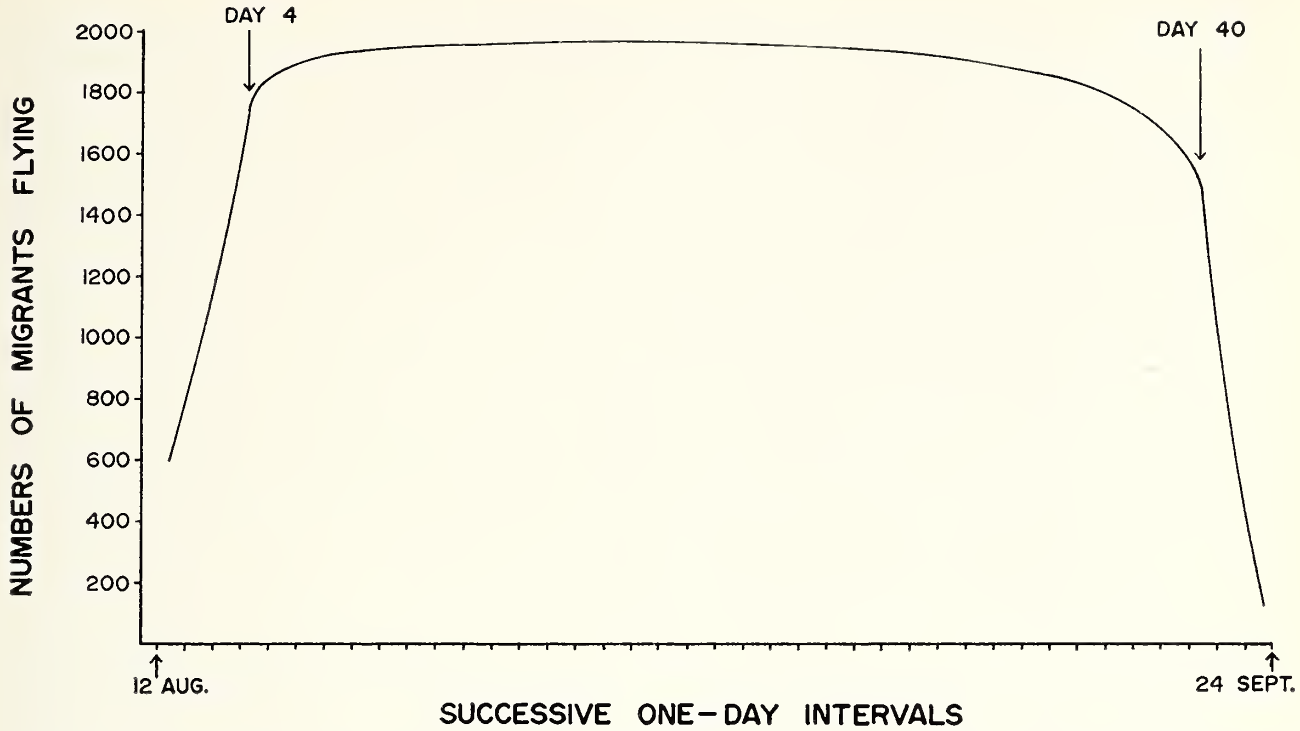

Fig. 2. The census history behavior of a migration of the tropical, day-flying moth *Urania fulgens* in Costa Rica. Out of the total of 42 days that the migration lasted, there were 30 days of censusing conducted among 3 different localities (see text for details); each of the 30 points plotted to construct this figure are counts of the total number of individuals counted on a given day. It was not possible to make counts at the 3 localities simultaneously, but it was highly probable that census history pattern was very similar among localities (in terms of numbers of individuals per day), as similar total numbers had been censused at each locality by the end of the study (see text for further explanation).

CONSISTENCY OF THE MIGRATION IN TIME. The "consistency" of an animal migration (in terms of numbers of individuals passing by a given point, rates of movements, etc.) can be described by means of some simple parameters. Underlying the significance of these parameters is the assumption that the localities studied are "typical" of most points along the migratory route(s) of the animal, in terms of general activity and behavior of the population. "Traffic" of the migration was estimated at Puerto Viejo by taking the median numbers of moths passing over the censusing point per minute for ten successive observations (Puerto Viejo was chosen for all calculations presented here since it was usually free of winds; a factor that could obviously bias movements of the population). Traffic rate was calculated to be 103 moths per minute. The speed of the migrating moths was found by counting the number of seconds an individual moth took to fly 30 feet in a straight line. This was done by standing in the center of the road and timing individuals as they flew over an area defined by wire fence located ten feet to either side of the ten-foot wide road and parallel with it; i.e., individuals were timed (with a stopwatch) from the moment they approached the fence on one side of the road until they reached the fence at the other side of the road, a total distance of 30 feet. The speed of migrating *Urania* was found to vary from 155 feet per minute during the morning (calculated between 9:00 and 11:00 AM) to 180 feet per minute during the late afternoon (calculated between 5:00 and 6:00 PM). At about 4:00 PM, the sky usually begins to darken over in this region of Costa Rica (Atlantic wet lowlands) and the increased speed of moths shortly thereafter could be a response to approaching nightfall (it is dark by 6:15 PM) in the way of finding suitable perches for the night. From the traffic rate (T) and the speed (S), density (T/S) of moths along the migratory route was found to vary from 0.55 to 0.66 moths per foot, as measured during the census history period when daily numbers of moths were about equal (from day 5 through day 40 of the migration, see Fig. 2). At the end of migration, of course, density declined and did so rapidly to a low of 0.14 moths per foot at day 41 (before going to 0 on day 42) since at this time, traffic rate had decreased to 23 moths per minute.

FUTURE STUDIES OF INSECT MIGRATION. Inasmuch as there is very little literature background with which to compare these particular observations and data, one at best can only discuss them as they stand, and without expecting the data to assume a particular form or pattern. In addition to migration, very little is known about the general biology and ecology of *Urania* during its sedentary phase of life. There are no life tables available for this species, nor have there been laboratory studies on the effects of various environmental factors on life history components (fecundity, fertility, life expectancy, etc.) underlying population growth. It needs to be determined as to what proportion of a *Urania* population migrates and what factor(s) initiate migration. Valerio (1966) reports that migrations of *Urania* originate just south of Lake Nicaragua which abuts on the northern border of Costa Rica. This is a montane wet forest region and is thus composed of many large canopy trees that support an abundant growth of epiphytes. It is from this forest region that Valerio and his students observed *Urania* migrations to originate. Possibly the larval host plant of *Urania* is located in the canopy flora; an extensive survey in 1964 in Costa Rica failed to disclose the larval host plant and it was subsequently suspected that it is part of the canopy in various forest regions. Initiation of *Urania* migrations may be, at least in part, due to changes in the growth of host plants that cause marked changes in their availability as food for *Urania* larvae. More documentation is needed on the effects of dry season upon canopy vegetation; there is some evidence that the dry season in certain parts of Costa Rica causes herbaceous vegetation to lose leaves and growth is decreased (Janzen and Schoener, 1968). And since the canopy receives the direct impact of prevailing climate, it is likely that a period of severe dryness such as the tropical dry season would undoubtedly alter the flora there. And if indeed larvae of *Urania* feed in the canopy, it is further likely that the life cycle and population dynamics of this migrant insect are timed with season.

Putting *Urania* into a perspective as a colonizing insect, its strategy of colonizing merits investigation. Some evidence has been presented here that indicates that *Urania* is a colonizing insect: migrating females are burdened with many eggs that are not deposited along migratory routes, the migrating population is young, and males accompany females on migrations suggesting that more than one generation may be produced at destination points. Viewed in ecological perspective, migration is synonomous with adaptive dispersal and denotes, as stated by Johnson (1966), "a periodic disintegration of the population pattern in its breeding habitat." Reproduction ceases in one habitat and commences later in the newly colonized habitat. While not using *Urania* as experimental material, it has been nicely demonstrated that the capacity for an insect to migrate is genetically determined (Dingle, 1968), and is therefore subject to the forces of natural selection. Lewontin (1965) in discussing the theoretical basis of the selection of life cycle components for colonizing ability in a species, suggested that any trend in the genotype towards increasing population growth potential will be of adaptive value to the colonizer. Studies of *Urania* and other migrant insects could be designed to test this interesting theory. The basic theme of these studies would be: any suppression of reproduction (e.g., by shorter days, lower temperatures, and high population densities) resulting from environmental factors which predict an unfavorable future will allow an insect (migrant colonizer) more time to migrate into a favorable habitat. Life tables obtained under various environmental conditions would be useful here in determination of the intrinsic rate of natural increases, *r*, and how it changes in relation to commencement of migration. It is advantageous to increase *r* genotypically and to thus allow a population of a migrant species to grow rapidly in numbers and fill a previously empty habitat (Lewontin, 1965). In the case of solely tropical migrant colonizers such as *Urania*, it would be worthwhile to see if seasonality (wet and dry seasons) was responsible for migration, as it is for temperate migrating insects.

Another interesting problem conducive to experimental analysis concerns the relationship of a migrating insect with the surrounding flora and fauna this species comes into contact with at various points of the migration. It might be worthwhile to demonstrate the relevance of a large scale insect migration as being a temporarily important prey source to certain species of birds and how such exploitation of a migrating insect population fits into daily and/or seasonal patterns of environmental exploitation by these predators.

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Temperature Changes Influencing Oviposition in *Crambus teterrellus* (Lepidoptera: Pyralidae)

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Abstract: Females of the bluegrass webworm *Crambus teterrellus* (Zincken) were exposed in the evening to 70 to 90 minutes temperature changes in illuminated incubators following at least 2 hr. of acclimatization. Significantly more moths oviposited during a 25° C to 15° C depression than during a 35° C to 25° C depression. Significantly more moths oviposited a significantly greater number of eggs during a 30° C to 20° C depression than during a 20° C to 30° C rise. Presence of males did not significantly affect numbers of females ovipositing or their average oviposition during a 30° C to 20° C depression. When wings, antennae, and tarsi were removed from females anesthetized with carbon dioxide, only those lacking tarsi oviposited in significantly greater numbers and laid significantly more eggs than did controls. Anesthetized controls laid significantly more eggs during a 30° C to 20° C depression than did nonanesthetized moths. The adaptive value of an oviposition response to temperature depression is discussed.

The large body of literature on temperature relations of insects has been reviewed by Bursell (1964) and by Clarke (1967), while the effects of temperature changes on insect nerve activity have recently been documented by Boistel (1968). In addition, the role of temperature changes on circadian activity has been discussed by Wilkins (1965). However, with the exception of a few isolated studies, little is known about the immediate effects of short-term temperature changes on the behavior of insects and other invertebrates.

Instances where temporarily increased activity has resulted from brief temperature depressions have been recorded in slugs (Dainton, 1954) and in crayfish and cockroaches (Kerkut and Taylor, 1958). In both of these investigations, as well as in studies of earthworms (Laverack, 1961), an administered temperature depression caused an increase in electrical activity in units of the nervous system. Activity increases in millipedes exposed to lowered temperature have also been reported by Cloudsley-Thompson (1951a, b).

Females of the bluegrass webworm, *Crambus teterrellus* (Zincken), are inhibited from ovipositing by light and oviposit primarily in response to a light-dark transition (Crawford, 1966). They also oviposit in response to a 25° C. to 15° C. temperature depression (Crawford, 1968). The present paper reports experiments performed in order to further characterize the oviposition response to a temperature change.

EFFECTS ON OVIPOSITION OF TWO RANGES OF TEMPERATURE DEPRESSION

Two groups of 60 adult female *C. teterrellus*, each moth being paired in a vial with a male, were used to study the extent to which two different ranges of temperature depression can influence onset of oviposition. All moths used were of the same age, having been collected in early August after dark as they emerged from the turf of an Albuquergue golf course nearly 48 hours prior to their exposure to controlled temperature changes. On the night of their emergence males and females were caged together outside in order to insure mating (Banerjee and Decker, 1966). The next day single pairs of males and females were placed in shell vials capped with moist cotton and then kept outside a second night.

Six hours before temperature depressions were administered on the following day the male and female in each vial were placed on the type of oviposition-measuring device described in a previous publication (Crawford, 1966). In order to acclimatize the moths to a desired temperature each device was then placed in a Hotpack model 525-2 incubator set at either 35° C. or at 25° C. This kind of incubator, illuminated by a bank of six 15-watt cool white fluorescent bulbs, was also used in the other experiments described below.

Negligible oviposition occurred during acclimatization periods in this and other experiments. At about the time of darkness outside each of the two ambient temperatures was gradually lowered 10° C. over a duration of 70 to 90 minutes. Eggs laid during this period were counted from charts to which the eggs adhered on the surface of oviposition drums.

The upper portion of Table 1 shows that nearly twice as many females oviposited during the 25° C. to 15° C. depression than oviposited during the 35° C. to 25° C. depression. A chi-square test for homogeneity indicates that this difference is highly significant ($P<0.001$). However, the average number of eggs laid by females in each treatment was not significantly different.

COMPARATIVE EFFECTS ON OVIPOSITION OF TEMPERATURE INCREASE AND DEPRESSION

The importance to oviposition induction of the direction of a temperature change was investigated by submitting 39 pairs of *C. teterrellus* adults to an increase of 20° C. to 30° C. while another 39 pairs were being exposed to a depression of 30° C. to 20° C. Exposures in this and in remaining experiments were made in the previously described illuminated incubators and also lasted from 70 to 90 minutes.

Moths used in this and in remaining experiments were all obtained in late summer when newly emerged adults were difficult to find in large numbers. Experimental insects were therefore collected as fresh-appearing adults from walls of buildings during the day. At least 3 hr before an evening temperature change was to be administered the moths were installed on oviposition-measuring devices and held at the temperature at which a specific experiment was to begin.

Results of exposure to raised and lowered temperatures are given in the lower portion of Table 1. It is evident that many more females experiencing the

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TABLE 1. Effects of various temperature changes on oviposition in bright light.

Temperature change	No. of females used	No. of females ovipositing	Mean no. of eggs laid[a]
Comparison of ranges of temperature depression			
35° C→ 25° C	60	25	5.97 ± 3.20
25° C→ 15° C	60	46	6.53 ± 2.08
Comparison of temperature rise and depression			
30° C→ 20° C	39	18	3.74 ± 2.33
20° C→ 30° C	39	4	0.13 ± 0.14

[a] Mean ± 95% confidence limits.

depression oviposited than did those experiencing the increase. A chi-square test for homogeneity indicates that the difference is highly significant ($P<0.001$). The results of a *t* test indicate that females experiencing the depression also exhibited significantly greater average oviposition during the period of exposure than did those experiencing the increase ($P<0.01$).

EFFECTS ON OVIPOSITION OF MALE PRESENCE DURING TEMPERATURE DEPRESSION

Results of earlier studies with *C. teterrellus* suggest that noncircadian oviposition occurs in darkness when males are not present and when ovipositing females are of an unknown age (Crawford, 1966). However, oviposition periodicity appears weakly circadian when males and females of the same age are caged as pairs in darkness (Crawford, 1968).

The effects of male presence on numbers of females ovipositing and on the extent of their oviposition during a 30° C. to 20° C. depression were tested by exposing 40 individually caged females to such a temperature change and by comparing the results with those described in the previous section for the same temperature change.

Twenty-four of the 40 single females oviposited during the test; this ratio is not significantly different from the 18 out of 39 paired females that oviposited under similar conditions (see Table 1). Furthermore, the average of 5.10 ± 1.94 eggs laid by single females is not significantly different from the 3.74 ± 2.33 eggs laid by the paired females.

ATTEMPTS TO DETERMINE AREA OF SENSITIVITY TO TEMPERATURE DEPRESSION IN FEMALE MOTHS

According to Wigglesworth (1965, p. 259–60) there are a number of temperature-sensitive regions in insects. Among these structures are antennae and

Table 2. Effects of surgical procedures on oviposition in bright light during a 30° C to 20° C depression.

Treatment	No. of females used	No. of females ovipositing	Mean no. of eggs laid[a]
Controls	40	27	15.15 ± 6.59
Wings removed	40	34	15.53 ± 4.99
Antennae removed	40	32	23.42 ± 6.95
Tarsi removed	40	36	30.23 ± 9.05

[a] Mean ± 95% confidence limits.

tarsi (or portions thereof), wings, abdomen, and cerci. In addition, sensitivity to high temperatures may be distributed over the entire body, as in grasshoppers.

In order to determine possible locations of receptors for temperature depression, individual females were initially anesthetized with a light application of carbon dioxide. Forty moths so treated were used as controls. Each of three other groups of 40 females was subjected to one of 3 surgical procedures in which a fine scissors was used while the moths were anesthesized. The operations were (1) removal of wings, (2) removal of antennae at the base of the flagellum, and (3) removal of all tarsi. All moths were then exposed while caged on oviposition-measuring devices to a 30° C. to 20° C. depression.

Table 2 gives the numbers of females that oviposited after each treatment. A chi-square test for homogeneity indicates that only those females with tarsi removed oviposited in greater numbers than did control moths ($P<0.05$). They also laid a significantly greater average number of eggs than did controls ($P<0.01$).

An additional observation in this study is that average oviposition by each group of previously anesthetized moths was considerably higher than that of moths which had been exposed to the same depression but which had not been anesthetized before their exposure (compare Tables 1 and 2). A *t* test indicates that average oviposition by anesthetized controls was significantly greater than that of the unanesthetized moths ($P<0.01$). However, a chi-square test of homogeneity indicates that the number of moths ovipositing in each instance was not significantly different.

DISCUSSION

From his extensive study on the biology of *C. teterrellus* Ainslie (1930) did not feel that "declining temperature" was associated with the induction of oviposition even though he did state (p. 19) that eggs are laid "beginning about 4 P.M." More recently obtained evidence, however, indicates that this kind of change in ambient temperature can stimulate oviposition notwithstanding the fact that a light-dark transition is the primary oviposition stimulus (Crawford, 1968).

It is clear from evidence given in the present paper that ovipositing *C. teterrellus* females are also able to discriminate between ranges of temperature depression as well as between a temperature depression and a temperature rise. Furthermore, the immediate presence of males appears not to affect the oviposition response to falling temperature.

It is plausible that the strong predusk oviposition response to a drop in moderate ambient temperature has adaptive value in late summer because the response allows females to advance their oviposition relative to onset of darkness and therefore relative to increasingly early low temperatures. As adult females only live about 7 to 10 days (Ainslie, 1930), the probable consequence of this early oviposition is that many larvae are available for overwintering.

The lack of a significant oviposition response to a temperature increase is consistent with observations that *C. teterrellus* does not oviposit around dawn (Ainslie, 1930; Banerjee and Decker, 1966; Crawford, 1966). Involved temperature receptors seem to be located throughout the body; at least they are evidently not on antennae, wings, or tarsi. Increased oviposition response to temperature depression following removal of tarsi suggests that tarsal receptors perhaps exert a moderating effect on an otherwise strong response to this stimulus. However, the considerable oviposition recorded may have been due to relatively great trauma caused by the operation.

Why anesthetized females should oviposit more than unanesthetized females is not clear. Carbon dioxide in certain concentrations can affect insect metabolism (Edwards, 1968), but the increased response to a temperature depression by previously anesthetized females does not appear to conform to proposed explanations of the action of carbon dioxide.

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Notes on the Myocoptidae of North America with Description of a New Species on the Eastern Chipmunk, *Tamias striatus* Linnaeus[1]

A. FAIN[2] AND K. HYLAND[3]

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Abstract: Six species and two subspecies are reported from North American rodents including the new species *Sciurocoptes* **tamias** from the Eastern Chipmunk, *Tamias striatus*. Synonymies are given.

The first myocoptid reported in North America was *Myocoptes musculinus* which Banks (1923) recorded from the house mouse at St. Paul Island, Pribilof Islands, Alaska. Later this same species was found on the same host in Mississippi by Smith (1955).

Flynn (1955) observed mange on laboratory mice infested with both *M. musculinus* and *M. romboutsi* (= *Trichoecius romboutsi*). Since then the presence of *M. musculinus* has been noted by various authors. Its distribution is discussed by Fain, Munting and Lukoschus (1970).

Radford (1955) described two new species of *Myocoptes*, *M. jamesoni* from *Microtus p. pennsylvanicus* collected in New York State, and *M. canadensis* from a lemming, *Dicrostomys* sp. taken in Ontario, Canada.

In 1960, Sengbusch observed mange on guinea pigs which he attributed to *M. musculinus*. In reality this was probably due to another mite, *Chirodiscoides caviae* Hirst.

It should be noted that various authors including Miller and Ward (1960), Elzinga and Rees (1964), and Drummond (1957), have reported the genus on different hosts as *Myocoptes* sp. In their publication, "Mites of Utah Mammals," Allred and Beck (1966) did not report finding any myocoptids.

During the past several years we have been carrying out research on the acarines of North American mammals and have found several species belonging to the family Myocoptidae, one of which is new and is described herein.

Several modifications have been made recently in the classification of this family. McDaniel (1968) has given family rank to the group. Fain, Munting

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and Lukoschus (1969) have accepted this new status and have proposed, in addition, several new synonymies. The genus *Neomyocoptes* Lawrence falls into synonymy with *Trichoecius* Canestrini; the names *Myocoptes jamesoni* Radford, 1955 and *M. glareoli* Samsinak, 1957, become synonyms of *Myocoptes japonensis* Radford, 1955; and *M. canadensis* Radford, 1955 is considered a subspecies of *M. japonensis*. In addition a new genus, *Sciurocoptes*, is erected for *M. sciurinus* Hennemann, 1910.

FAMILY MYOCOPTIDAE Gunther, 1942

Genus *Myocoptes* Claparède, 1869

1. *Myocoptes musculinus* (C. L. Koch, 1844)

This species has been recorded from many countries on the house mouse and from colonies of laboratory mice. Fain, Munting and Lukoschus (1969, and 1970) give a detailed distribution and bibliography for this species. They also report finding this mite on *Apodemus sylvaticus* in Belgium and Holland.

In North America *M. musculinus* was reported for the first time on *Mus musculus* by Banks (1923). Since then it had been recorded repeatedly from this continent on the same host, especially in colonies of laboratory mice.

In Rhode Island we have found it on house mice in South Kingstown (9 Feb. 1959; Coll., J. Hammar) and on Block Island (25 Oct. 1956; Coll., K. Hyland). The latter host was one of several house mice collected in an open field during the Rhode Island Mammal Survey (Cronan and Brooks, 1962). This mite has also been taken from laboratory mice in Kingston (15 Sept. 1961). More recently we have found it on the posterior legs and venter of several *Peromyscus leucopus* from South Kingstown (October, 1968; Coll., G. Clough).

While *M. musculus* is obviously the natural host for this species its occurrence on *P. leucopus* can be easily understood because of the frequency with which this mouse invades buildings and the frequency with which *M. musculus* will leave buildings for fields and swamps. In Belgium and Holland *Apodemus sylvaticus* is the most abundant rodent and it obviously has ample opportunity to mingle with *M. musculus*, although it probably does not invade homes to the extent found in *P. leucopus*.

2. *Myocoptes japonensis* Radford, 1955

Myocoptes jamesoni Radford, 1955; Fain et al., 1969
Myocoptes glareoli Samsinak, 1957; Fain et al., 1969

This species was described by Radford (1955) from a single male specimen collected on *Clethrionomys rufocanus smithii* (family Cricetidae) in Japan. In the same paper Radford described two other species, also on Cricetidae: *Myocoptes jamesoni*, known only from females collected on *Microtus pennsyl-*

vanicus in New York, and *Myocoptes canadensis*, represented only by the male and found on a lemming (*Dicrostomys* sp.) from Canada.

In 1957, Samsinak described a new species, *Myocoptes glareoli*, from *Clethrionomys glareolus* in Czechoslovakia.

Recently, Fain et al. have collected many myocoptids in Belgium and Holland on various Cricetidae, among them numerous *Clethrionomys glareolus*. The comparison of this material with the types of the species described by Radford have shown that there are no significative differences between *M. japonensis*, *M. jamesoni* and *M. glareoli*. They have therefore synonymized these species; in addition they consider *Myocoptes canadensis* as constituting a subspecies of *Myocoptes japonensis*.

Dr. Radford has kindly sent us types of his species.

Myocoptes japonensis japonensis Radford, 1955

In Rhode Island we have found numerous specimens of this subspecies on the following hosts:

1. *Clethrionomys gapperi*: Kingston, 23 Oct. 1968, Coll., G. Clough. This host has already been recorded by Fain et al. (1970). The mites were taken from the posterior legs.
2. *Microtus pennsylvanicus*: This is the type host for *Myocoptes jamesoni* Radford; the type locality is Ithaca, N. Y. This host has also been found parasitized by Fain et al. (1970) in West Kingston (R. I.), 27 Oct. 1968 (Coll., G. Clough). Other new localities in Rhode Island are Prudence Is., 12 June 1956 (Coll., W. Jones and J. Cronan); Patience Is., 13 June 1956 (Coll., J. Cronan and T. Fanning); Dutch Is., 14 June 1956 (Coll., J. Cronan, T. Fanning, K. Hyland); Charlestown, 8 Nov. 1955 (Coll., W. Jones and T. Fanning); South Kingstown, 31 Oct. 1957 (Coll., W. Jones), and 9 Nov. 1955, (Coll., T. Fanning) Narragansett, 11 July 1956 (Coll., W. Mulhearn).
3. *Marmota monax*: South Kingstown, R. I., 6 Aug. 1956. While many specimens of this host were collected during the survey conducted in Rhode Island only a single female specimen of this mite has been recorded. Probably this constitutes an accidental record.

Myocoptes japonensis canadensis Radford, 1955

The type host of this subspecies is a lemming, *Dicrostomys* sp. Only the male was described by Radford.

Recently Fain et al. (1970) found numerous examples, both male and female, on a specimen of *Dicrostomys rubricatus* from Canada. These mites

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FIG. 1. *Myocoptes japonensis canadensis* Radford. Female, ventral view.

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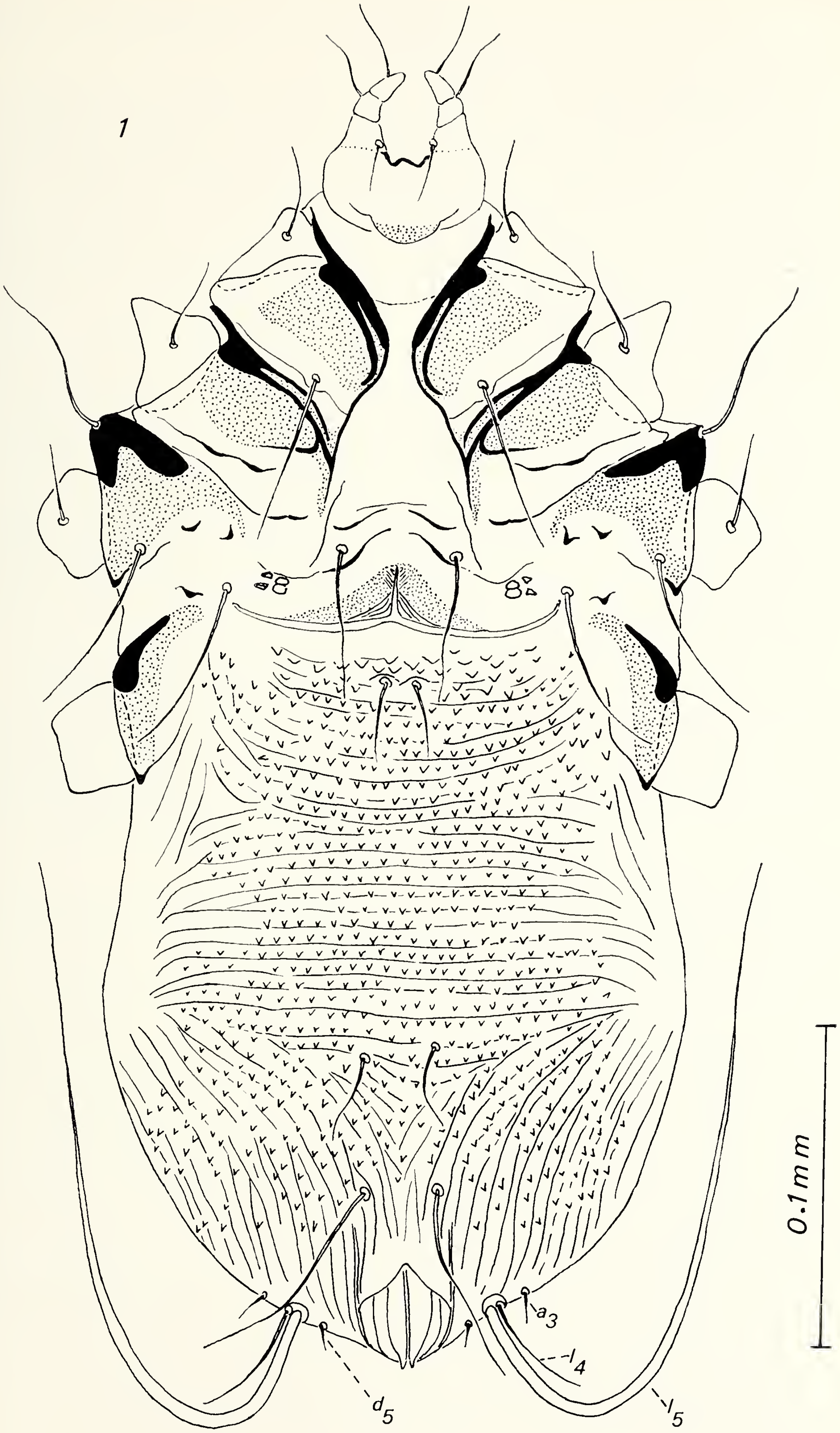


differ from the typical form of *Myocoptes japonensis* by several characters which are of little importance and which do not justify, in our estimation, their separation as a distinct species.

The following are the principal characters which separate *canadensis* from the typical form. In the female, (1) the form of the scales on the venter of the podosoma: in *canadensis* coxae II bear one well-formed scale and several short, wide and badly formed scales, whereas in *j. japonensis* there are habitually four to six well-formed scales on these coxae; (2) setae *a 3* are approximately three times shorter (8 to 12 μ) than *l 4* (28 to 32 μ) whereas in *j. japonensis* *a 3* varies from being subequal to distinctly longer than *l 4*.

In the male, (1) the posterior lobes of the body are broader and more widely separated (distance 12 to 13 μ) compared with 6 to 9 μ in the typical form; (2) the scales on coxae I and II are badly formed, short and wide, and resemble to a considerable extent cuticular folds; (3) the body is longer (270 to 285 μ instead of 215 to 276 μ) than in the original species.

Myocoptes japonensis japonensis has been redescribed in a previous paper by Fain et al. (1970), and they have given the principal measurements of *M. j. canadensis*. The venter of the female of *canadensis* is figured again so as to show the form of the coxal scales (Fig. 1).

3. *Myocoptes squamosus* Fain, Munting and Lukoschus, 1969

This species was described from *Microtus oeconomus* in Holland. We have found two specimens (male and female) of this species on two *Microtus pennsylvanicus* from Patience Island, (13 June 1956; coll., J. Cronan) and Charlestown, (8 Nov. 1955; coll. W. Jones and T. Fanning) in Rhode Island.

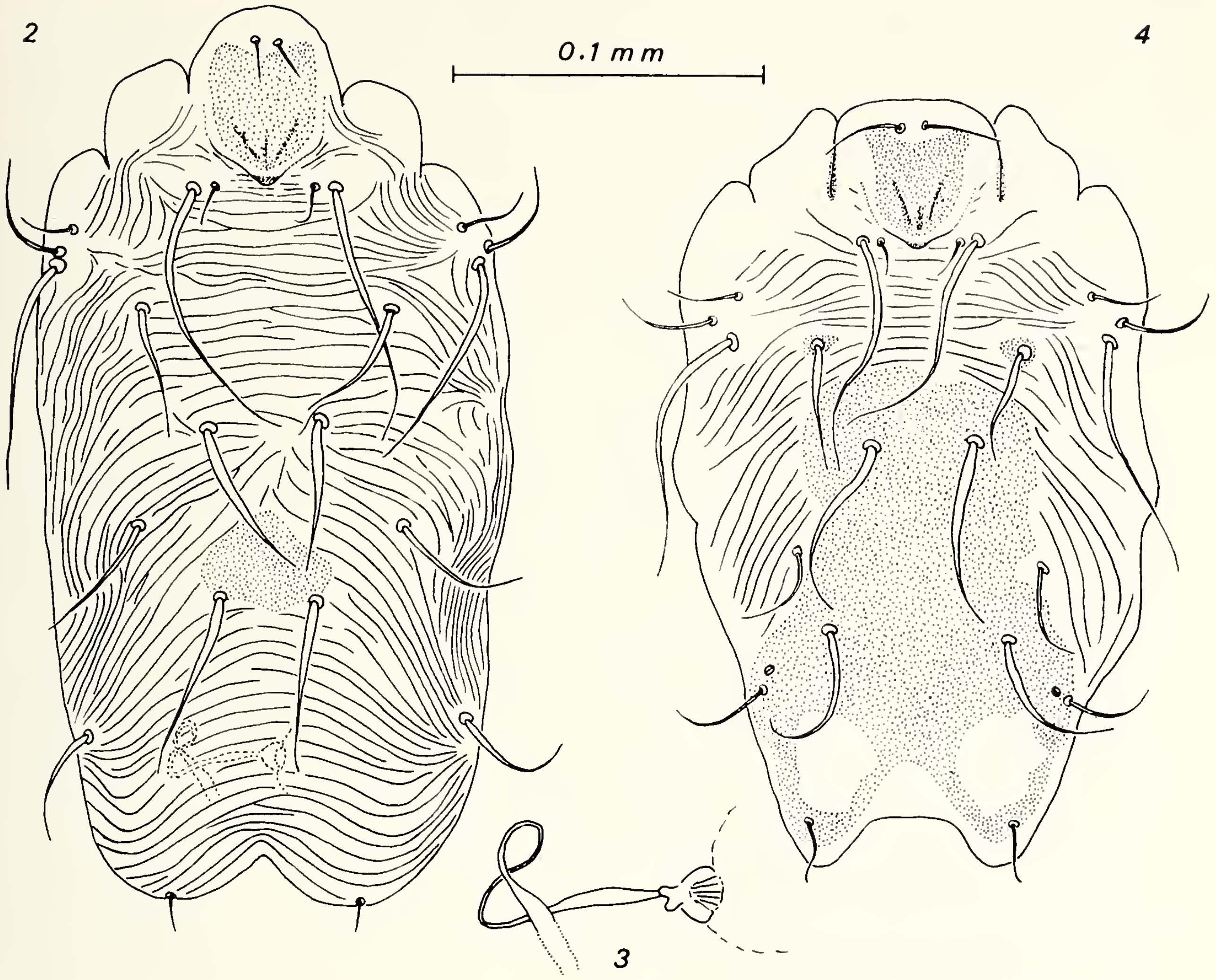
Genus *Trichoecius* Canestrini, 1899

Trichobius Canestrini, 1897 (not *Trichobius* Townsend, 1891)
Trichoecius Canestrini, 1899 **Nov. nom.**
Neomyocoptes Lawrence, 1953; Fain et al., 1969 **Nov. syn.**

Examination of the types of *Myocoptes brevipes* Trouessart and Canestrini, 1895 (type of the genus *Trichoecius*) has shown that this species is not separable from *Myocoptes tenax* Michael, 1889. Since *Myocoptes kalrai* Radford, 1947, type of the genus *Neomyocoptes*, obviously belongs to the same genus as *M. tenax*, it is clear that *Neomyocoptes* Lawrence becomes a synonym of *Trichoecius*.

1. *Trichoecius tenax* (Michael, 1889)

Myocoptes tenax Michael, 1889
Myocoptes brevipes Trouessart et Canestrini, 1895
Trichoecius brevipes, Canestrini, 1899
Neomyocoptes tenax, Lawrence, 1956
Trichoecius tenax, Fain et al., 1969



Figs. 2–4. *Sciurocoptes* **tamias** n. sp. 2. Holotype female in dorsal view. 3. Bursa copulatrix. 4. Allotype male in dorsal view.

This species had not been reported previously from North America. We found females, males and nymphs of this species on several *Microtus pennsylvanicus* from two different localities in Rhode Island: Charlestown, 8 Nov. 1955 (coll. W. Jones and T. Fanning) and Patience Island in Rhode Island, 13 June 1956 (coll., J. Cronan and T. Fanning).

A new description with figures has been given by Fain et al. (1970).

2. *Trichoecius romboutsi* (van Eyndhoven, 1946)
Myocoptes romboutsi van Eyndhoven, 1946
Trichoecius romboutsi, Fain et al., 1969 **Nov. comb.**

This species has been reported from the laboratory mouse in U.S.A. by Flynn (1955). Dr. Flynn kindly sent us specimens for our study. A new description of this species has been given by Fain et al. (*in press*).

Genus *Sciurocoptes* Fain, Munting and Lukoschus, 1969

1. *Sciurocoptes* **tamias** n. sp.

FEMALE (holotype) (Fig. 2). Total length of the body, including gnathosoma, 305 μ; maximum width 165 μ (Paratype: 359 μ long by 202 μ wide). Posterior margin distinctly incised. Cuticle striated, but striations poorly developed on the venter of the podosoma and are lacking on the dorsum in the areas covered by the two punctate shields. Propodosomal and opisthosomal shields conspicuous. The latter very small (30 μ long, 40 μ wide) and located immediately in front of setae *d 3*. In the paratype this shield is 28 μ long and 36 μ wide. Ventral surface of opisthosoma with 22–23 transverse rows of small triangular cuticular scales. Epigynium crescentic, well developed. Vulva in the shape of an inverted Y. Bursa copulatrix (Fig. 3) shorter than in *Sciurocoptes sciurinus*, beginning distally with a short fusiform portion, and consisting of two loops. All the epimera free. Legs and gnathosoma as in *sciurocoptes sciurinus*. Number of idiosomal setae as in *S. sciurinus*. Length of setae: *sc e*—80 μ, *d 1*—45 μ, *d 2*—57 μ, *d 3*—57 μ, *d 5*—210 μ, *l 5*—170 μ.

MALE (allotype) (Fig. 4). Total length including gnathosoma 261 μ; width 160 μ. Posterior margin with a large median incision. Cuticle sparsely striated. Dorsally the propodosomal shield is similar to that of the female; hysterosomal shield large, length along the midline 120 μ, maximum width 99 μ, and minimum width 60 μ. This shield does not cover completely the posterior part of the opisthosoma which bears two lateral, bare and more or less oval areas. Male sclerite long and narrow, measuring 54 μ in the midline.

SYSTEMATIC POSITION OF *Sciurocoptes* **tamias.** This species is distinguished from *S. sciurinus* by the following characters: in the female by the smaller size of the body; the relatively much smaller size of the hysterosomal shield, which is nearly vestigial; the broader area of scales on the ventral surface of the opisthosoma and the different shape of this area which is rather regularly rectangular and distinctly wider than long. In the male by the different shape of the hysterosomal shield; the much smaller size of the coxal shields; the longer size of the genital sclerite.

HOST AND LOCALITY. Two female and one male specimens were collected on the hairs of an Eastern Chipmunk, *Tamias striatus*, from an unknown locality in North America, which had died in the Antwerp Zoo, soon after its arrival (Coll., A. Fain, 7 July 1964). Holotype and allotype are in the Institut royal des Sciences naturelles de Belgique (Brussels). Remaining female in the collection of A. Fain.

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A New Genus and Eight New Species of Mexican Hesperiidae (Lepidoptera)

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Abstract: One new genus and eight new species of hesperiids are described from Mexico. The genus is named **Zobera**. The species described and illustrated are *Urbanus* **viridis**, **Zobera albopunctata,** *Piruna* **maculata,** *P.* **sina,** *P.* **ajijiciensis,** *P.* **milpa,** *Amblyscirtes* **immaculatus**, and *Aedes* **brilla**.

During the process of making a detailed study of the Hesperiidae of Mexico recent research has led to the discovery of eight more new species and one new genus. Two of the new species were located among specimens received from the American Museum of Natural History, New York, for determination, one among material received from Dr. Tarsicio Escalante, Mexico, D. F., for determination, three new species and a new genus were located among specimens obtained from Robert Wind, one from material obtained from Kent Wilson, and one new species I collected recently.

Urbanus **viridis**, n. sp.

Figs. 1, 2, 17

MALE (Upper Side). Primaries dark brown, with some green hair-like scales covering the area from the discal band to the base. The transverse discal band is made up of four white hyaline spots; one in space 1b, situated about midway between the outer edge of the spot in space 2 and the outer margin; one in space 2, squarish and large (2.5 mm), extending to midway beneath the cell spot; cell spot broadly columnar, somewhat broader at the anterior edge; and costal spot, directly anterior to cell spot, approximately same width as cell spot. There is a squarish spot in space 3, situated directly anterior to the spot in space 1b. There are three well-defined subapical spots of the same white hyaline color as all other spots, in spaces 6, 7, and 8. The two upper or anterior ones are approximately the same length, elongated and superimposed, while the lower or posterior one is smaller and is situated outward from the spot in space 7. The fringes are checkered. There is no costal fold.

Secondaries dark brownish-black, with the cell, the inner two thirds of the basal area, and along the abdominal fold to the beginning of the tails heavily overscaled with shiny greenish-blue hair scales. The tails are 8 mm long. The fringes above the tails are lightly checkered. The outer margin from the apex to the tail is evenly straight.

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MALE (Under Side). Primaries pale brown, with the hyaline spots all repeated and of the same color as above. Space 2 is darker brown than the surrounding area and this color forms a broad submarginal band extending from space 2 to the outer edge of the subapical spots.

Secondaries brown, with a few scattered white scales in space 1, darker over anal fold and tails. The subbasal band of dark brown spots is composed of two in space 7, the one near the base is square and twice the size of the round centrally located one; a dark, white edged cell spot, located directly ventral to the centrally located spot in space 7; and a well defined dark spot below the base of vein 2. The dark discal band extends from vein 6 downward to vein 1, where it is outwardly white edged in space 1. This discal band is broken into a series of separate spots due to the lighter veins present.

Thorax above brown, overscaled with greenish hair scales, beneath lighter brown. Abdomen dark brown above, heavily overscaled with greenish-blue hair scales, beneath lighter brown. Head green, with a few brown scales intermixed. Palpi gray, with a few lateral yellowish scales present. Pectus brown. Legs, light brown. Antennae, both shaft and club, dark brown above, below slightly lighter, especially which contains a few yellow scales.

WING MEASUREMENTS. Primaries; base to apex, 21.5 mm; apex to outer angle, 15.5 mm; outer angle to base, 15 mm. Secondaries; base to end of vein 3, 12 mm; center of costa to end of tail, 25 mm. Total expanse: 40 mm.

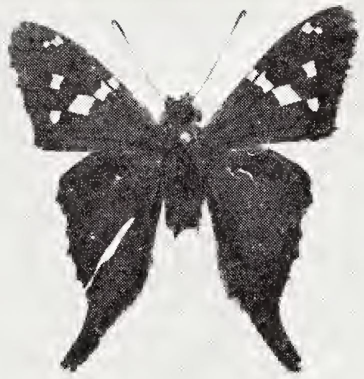
TYPE MATERIAL. Holotype, male, Fortin de los Flores, Veracruz, Mexico, 15 August 1967 (H. A. Freeman collector), will be placed in the American Museum of Natural History, New York.

Superficially *U.* **viridis** resembles *U. esta* Evans on the upper side and *U. pronta* Evans on the lower side, with the following differences noted: (1) the tails of **viridis** are slightly shorter than those of *esta*; (2) the green scales on the upper side of the primaries of **viridis** are more extensive than those of *esta*; (3) on the lower side of the secondaries the general maculation of **viridis** resembles *pronta* except that *pronta* is much darker, with the separation of the discal band into spots being a little more pronounced; (4) **viridis** lacks a costal fold similar to *esta*, whereas *pronta* has a costal fold; and (5) the genitalia are symmetrical and somewhat resemble the shape of the genitalia of *esma* Evans, however there are marked differences as can be found by comparing Figure 17 with Evans Figure 7, Plate 18, and *esma* has a well developed costal fold, and the discal band on the lower side of the secondaries is compact.

ZOBERA, n. gen.

GENEROTYPE. **Zobera albopunctata** n. gen., n. sp.

Antennae approximately one half the length of the costa; club evenly curved, with nudum 18 segments, and apiculus longer than rest of club; shaft checkered. Palpi elongated, extending well beyond the head, porrect. Mid tibia smooth, with one pair of spurs. Hind tibia with two pairs of spurs and a prominent tibial tuft that fits into a well developed thoracic pouch. Short white hair-like fringe on both mid and hind tibia. Primaries rounded very similar to *Carrhenes* Godman & Salvin. Well developed costal fold terminating directly above or dorsal to the end of the cell. Secondaries excavated in spaces 4 and 5, slightly resembling the general shape of members of the genus *Systasea* Edwards. There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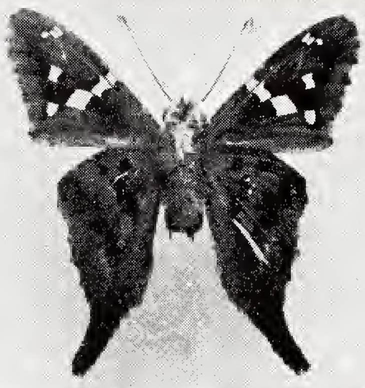
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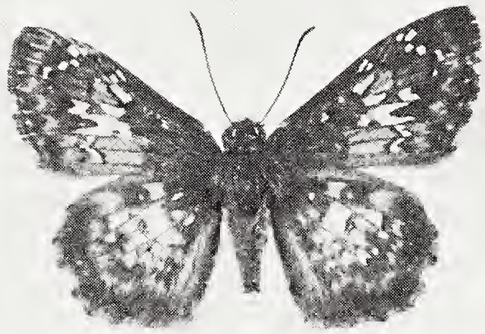
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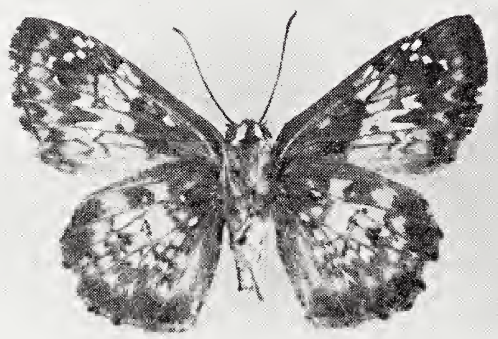
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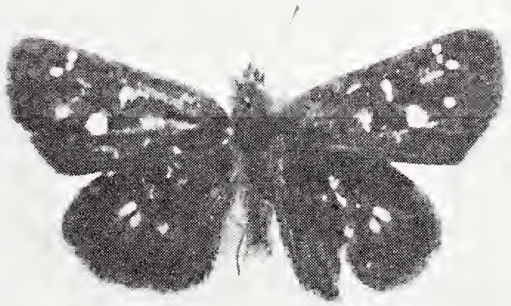
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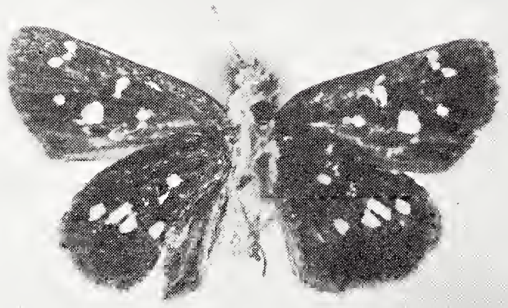
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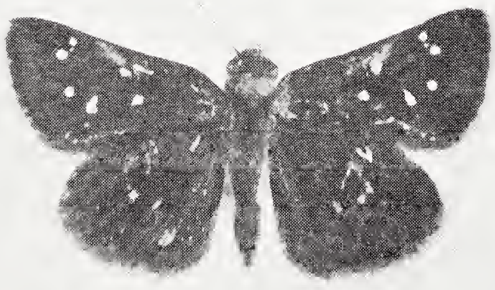
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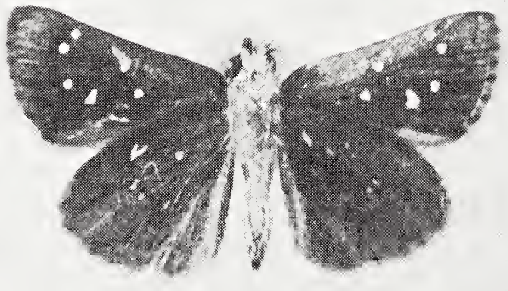
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Figs. 1, 2. *Urbanus* **viridis**, n. sp. Holotype, male, Fortin de los Flores, Veracruz, Mexico, 15 August 1967 (H. A. Freeman; A.M.N.H.).

Figs. 3, 4. **Zobera albopunctata**, n. sp. Paratype, male, Salada, Colima, Mexico, 13 June 1967 (Robert Wind; H.A.F.).

Figs. 5, 6. *Piruna* **maculata**, n. sp. Paratype, male, Sinaloa, Durango-Villa Union Highway, Rt. 40, Mexico, 29 April 1966 (Peter Hubbell; H.A.F.).

are well developed hyaline spots on both the primaries and secondaries. Uncus, elongated, slightly tapered, undivided. Valva with an elongated style on dorsal surface.

Structurally this genus appears to be related to both *Carrhenes* and *Systasea.* The general characteristics of the primaries such as venation and wing shape approach *Carrhenes,* while the secondaries more closely resemble *Systasea.* The presence of well developed hyaline spots on both pairs of wings does not approach either genus. The tibial tuft and well developed thoracic pouch resembles those structures found in *Antigonus* Hubner more so than in either *Carrhenes* or *Systasea.* The genitalia are unusual in that the valva have a well developed style somewhat resembling the general shape of that structure found in *Systasea evansi* (Bell), whereas the uncus is elongated and undivided unlike the uncus found in any of the three mentioned genera.

This new genus is erected to contain a new species collected by Mr. Robert Wind at Salada, Colima, Mexico.

Zobera albopunctata, n. sp.

Figs. 3, 4, 18

MALE (Upper Side). Primaries grayish-brown, somewhat lighter through the discal area. There are linear spots in spaces 1a and 1b, situated beneath the center of the broadly C-shaped spot in space 2. In space 3 is located a rectangular spot just above the upper outer edge of the spot in space 2. There are small spots in spaces 4 and 5 that are surrounded by black scales. There are four apical spots in spaces 6, 7, 8, and 9, with the ones in spaces 6 and 8 in line and the ones in 7 and 9 in line. There are two linear cell spots, with two minute spots in spaces 10 and 11 directly above the inner edge of the upper cell spot. Just basad from the large spot in space 2 is a smaller round spot. All spots are white hyaline. Basad from the cell spots is a black dot and there are two black dots near the outer angle in spaces 1a and 1b. There is a well developed costal fold which terminates at the small spot in space 11. Fringes slightly checkered light and dark brown.

Secondaries grayish-brown, lighter over the discal area. There is a double, irregular row of discal spots beginning at space 1c and extending to space 6. There is a large, square, cell spot with two spots beneath this area and one directly above it in space 7. Basad from the cell spot are two small, round, spots. All spots are white hyaline. In the submarginal area there is a series of small lunules, extending from space 1c to space 7 where there is a much larger, broadly C-shaped lighter area. The veins are slightly lighter than the ground color. Outer margin excavated at spaces 4 and 5. Fringes checkered light and dark brown.

MALE (Under Side). Primaries light brown, being much lighter over the discal area, and in space 1. There is a well developed row of lunules in the submarginal area, extending from space 1 to the apex. All white hyaline spots are well developed.

Secondaries light brown, with all spots reappearing and the submarginal lunules are much more distinct. The dark marginal border becomes more or less macular. The veins are slightly lighter than the ground color.

Thorax above grayish-brown, light tan beneath. Abdomen grayish-brown above, light

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Figs. 7, 8. *Piruna* **sina**, n. sp. Holotype, male, Sinaloa, Durango-Villa Union Highway, Rt. 40, Mexico, 29 April 1966 (Peter Hubbell; A.M.N.H.).

tan beneath. Head dark brown. Palpi light tan. Legs tan. Antennae, both shaft and club, dark brown above, lighter beneath.

WING MEASUREMENTS. Primaries; base to apex, 20 mm; apex to outer angle, 11 mm; outer angle to base, 14 mm. Secondaries; base to end of vein 3, 13 mm; center of costa to anal angle, 13 mm. Total expanse, 36 mm.

TYPE MATERIAL. Holotype, male, Salada, Colima, Mexico, 13 June 1967, will be placed in the American Museum of Natural History, New York. There is one male paratype, same location and date in my collection. Both specimens were collected by Robert Wind.

Superficially this new species resembles no other hesperiid.

Piruna **maculata**, n. sp.

Figs. 5, 6, 19

MALE (Upper Side). Primaries brownish-black. There is a round spot in space 2 and a smaller, basal, spot in the same space situated inward from the cell spot. There may or may not be a minute dot in space 1a just below the outer edge of the large spot in space 2. Some specimens have a white streak in space 1b below the basal spot in space 2. In space 3 there is a round spot situated outward from the spot in space 2. The cell spot is small and somewhat triangular. There are three well developed apical spots in spaces 6, 7, and 8, with the one in space 7 being slightly smaller than the other two and situated slightly inward from them. All spots are white hyaline. Fringes concolorous with rest of wing except at outer angle where they are slightly lighter in coloration.

Secondaries dark brownish-black. There is a distinct double spot at the end of the cell and another one in space 2. All three spots are white hyaline. Fringes slightly lighter brown than the rest of the wing.

MALE (Under Side). Primaries dark chocolate brown, except in space 1 where there is a lighter brown area. All spots reappear and are very distinct. There is a small amount of golden overscaling present especially at the apex.

Secondaries dark chocolate brown, lightly overscaled with golden scales. The spots are silvery white and much more distinct than above, and besides the two spots at the end of the cell and in space 2 there is a distinct cell spot, another large one situated outward from the upper edge of the double spots at the end of the cell, and also there are two indistinct ones in spaces 1c and 1b.

Thorax above dark brownish-black, beneath slightly lighter. Abdomen above dark brownish-black, beneath slightly lighter. Head dark brown. Palpi dark gray and brown intermixed. Legs light brown. Antennae, both shaft and club, dark brown above, slightly lighter beneath.

WING MEASUREMENTS. Primaries; base to apex, 13 mm; apex to outer angle, 8 mm; outer angle to base, 11 mm. Secondaries; base to end of vein 3, 10.5 mm; center of costa to anal angle, 9 mm. Total expanse, 28 mm.

FEMALE. Similar in all respects to the male except the spots both above and below are slightly larger and more distinct.

TYPE MATERIAL. Holotype, male, Sinaloa, Durango-Villa Union Highway, Rt. 40, Mexico, el. 6500 ft., 29 April 1966 (Peter Hubbell collector), is in the American Museum of Natural History, New York. Allotype, female, same date, location, and collector, is also in the American Museum of Natural History.

There are four male paratypes, same date, location, and collector, two are in the collection of H. A. Freeman, and the other two are in the American Museum of Natural History.

There is a slight superficial resemblance of *P.* **maculata** to *P. polingii* (Barnes), however the following differences distinguish the two species: (1) **maculata** is slightly larger in size than the average *polingii;* (2) **maculata** is darker and the spots are larger and better defined, both above and below; (3) the basal spot in space 2 in **maculata** is situated inward from the cell spot, while in *polingii* it is usually located nearly beneath the cell spot; (4) the ground color in **maculata** is darker on the lower surface of both wings than in *polingii*, as it is a dark chocolate brown, while in *polingii* it is ferruginous; (5) on the lower surface of the secondaries in **maculata** there is a well developed silvery white spot slightly outward from the double spots at the end of the cell, which is not present in *polingii;* and (6) the genitalia are distinctly different.

Piruna **sina**, n. sp.

Figs. 7, 8, 20

MALE (Upper Side). Primaries dark brownish-black. There is a linear spot in space 2 and a somewhat larger, round basal spot in the same space situated slightly inward from the cell spot. There is a minute, round, spot in space 3 situated well outward from the linear spot in space 2. The cell spot is round and well defined. There are three apical spots in spaces 6, 7, and 8, in line, with the one in space 7 being a minute dot. All spots are white hyaline. Fringes light tan.

Secondaries dark brownish-black, with a minute double spot at the end of the cell, and another very tiny linear spot in space 2. Fringes light tan.

MALE (Under Side). Primaries brown, overscaled with ochreous scales, especially near the apex. All spots reappear and are well defined.

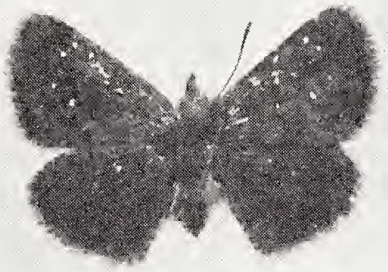
Secondaries brown, overscaled with rather sparse ochreous scales. There is a well developed cell spot and the other spots that appear on the upper surface are well defined, and also there is a submarginal row of 4–5 minute white dots in spaces 1–4.

Thorax above dark brownish-black, lighter beneath. Abdomen above dark brownish-black, slightly lighter beneath. Head brownish-black. Palpi dark gray. Legs light brown. Antennae, both shaft and club, dark brown above, lighter beneath.

WING MEASUREMENTS: Primaries; base to apex, 12 mm; apex to outer angle, 8 mm; outer angle to base, 11 mm. Secondaries; base to end of vein 3, 11 mm; center of costa to anal angle, 9 mm. Total expanse: 26 mm.

TYPE MATERIAL. Holotype, male, Sinaloa, Durango-Villa Union Highway, Rt. 40, Mexico, el. 6500 ft., 29 April 1966 (Peter Hubbell collector), is in the American Museum of Natural History, New York. There are three male paratypes from the same location, date and collector, two are in the collection of H. A. Freeman, and the other in the American Museum of Natural History.

The nearest related species to *P.* **sina** is *P. gyrans* (Plotz), from which it can be distinguished by the following characteristics: (1) **sina** is slightly darker in coloration; (2) the spots are larger in *gyrans* and are more fulvous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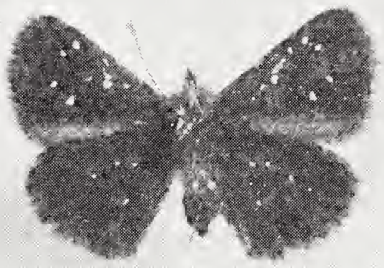
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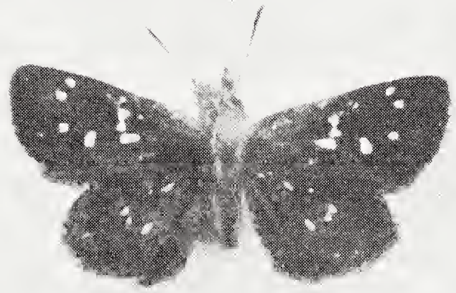
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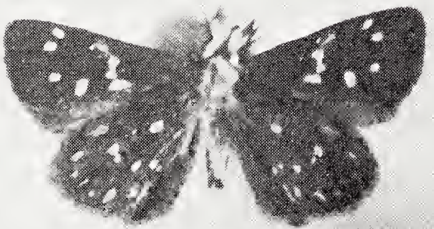
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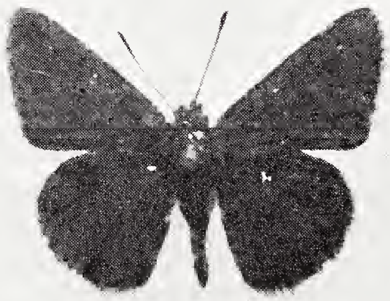
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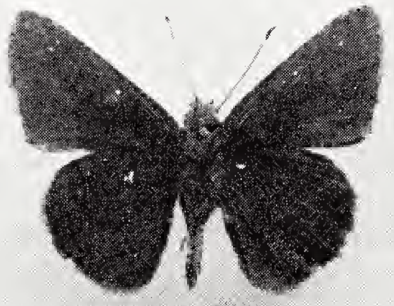
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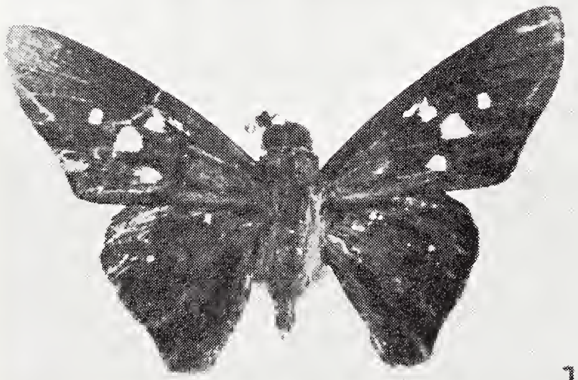
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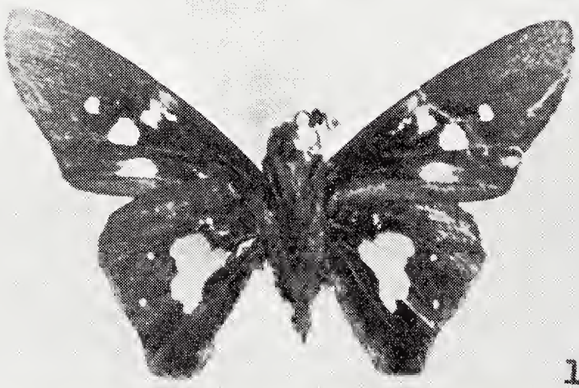
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Figs. 9, 10. *Piruna* **ajijiciensis**, n. sp. Paratype, male, Ajijic, Jalisco, Mexico, 3 October 1965 (Robert Wind; H.A.F.).

Figs. 11, 12. *Piruna* **milpa**, n. sp. Holotype, male, Milpillas, Guerrero, Mexico, 6 July 1956 (Kent Wilson; A.M.N.H.).

Figs. 13, 14. *Amblyscirtes* **immaculatus**, n. sp. Holotype, male, Salada, Colima, Mexico, 4 June 1967 (Robert Wind; A.M.N.H.).

than in **sina**, where they are clear white; (3) on the lower surface of the secondaries in **sina** the ground color is brown causing the minute white spots to be more distinct, while in *gyrans* the ground color is greenish-gray and the spots are very indistinct; (4) in **sina**, on the lower surface of the secondaries, there is an indistinct row of minute submarginal white spots that is entirely absent in *gyrans*; (5) there are distinct differences in the genitalia.

Piruna **ajijiciensis**, n. sp.

Figs. 9, 10, 21

MALE (Upper Side). Primaries somewhat evenly rounded and dark brown. There are five minute, white spots present, one in space 2, one in space 3, one in the cell, and two apical spots, one in space 6, and one in space 8. Fringes concolorous with rest of wing.

Secondaries dark brown, with no spots present. Fringes concolorous with rest of wing.

MALE (Under Side). Primaries light brown, with some golden scales near the apex. The five white spots are present and more distinct than above.

Secondaries light brown, with from 4–7 minute white spots present. There is a minute cell spot, a tiny dot at end of the cell, a dot in space 6, and in space 7. Midway between the spot in space 6 and the dot at the end of the cell there is a minute dot. There may be present a dot in space 2.

Thorax above dark brown, beneath same color. Abdomen above and below dark brown. Head dark brown. Palpi grayish-brown. Legs brown. Antennae, both shaft and club, brown above, slightly lighter beneath, especially the club.

WING MEASUREMENTS: Primaries; base to apex, 9 mm; apex to outer angle, 6.5 mm; outer angle to base, 7.5 mm. Secondaries; base to end of vein 3, 8 mm; center of costa to anal angle, 6 mm. Total expanse: 19.5 mm.

FEMALE. Very similar to the male except it is slightly larger, total expanse 20.5 mm, and the spots are larger and better defined.

TYPE MATERIAL. Holotype, male, Ajijic, Jalisco, Mexico, 20 July 1966, will be placed in the American Museum of Natural History, New York. Allotype, female, same location, 22 October 1965, is in the collection of H. A. Freeman. There are four male paratypes from the same location, August, October, and November, 1965 and 1966 in H. A. Freeman collection. All specimens were collected by Robert Wind.

This new species is a member of the *cingo* complex which is made up of several species in which the spot in space 7 on the lower surface of the secondaries is placed midway between the spot in space 6 and the spot at the end of the cell. In the *microsticta* complex, on the lower surface of the secondaries, the spot in space 7 is placed immediately over the spot at the end of the cell. The nearest related species is *cingo* Evans from which **ajijiciensis** can be separated by the following characteristics: (1) in **ajijiciensis** the wings are more evenly rounded than in *cingo*; (2) **ajijiciensis** is slightly smaller and

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Figs. 15, 16. *Aedes* **brilla**, n. sp. Holotype, male, Catemaco, Veracruz, Mexico, January 1953 (Tarsicio Escalante; A.M.N.H.).

darker than *cingo*; (3) the maculation, both above and below, in **ajijiciensis** is greatly reduced from that in *cingo* slightly approaching the Guatemala species *sombra* Evans; (4) on the lower surface of the wings in *cingo* there is a tendency for the veins to be lighter than the ground color, whereas in **ajijiciensis** this does not occur; and (5) there are differences in the genitalia.

Piruna **milpa**, n. sp.

Figs. 11, 12, 22

MALE (Upper Side). Primaries dark brown. There are six white hyaline spots present; one is a linear spot extending throughout the cell; there is an oval spot in space 2 and an elongated basal spot in space 2 directly beneath the cell spot; there is a small, oval, spot in space 3; and there are two well developed apical spots in spaces 6 and 8. Fringes slightly lighter than the ground color.

Secondaries dark brown. There is a well developed, linear, cell spot, and two connected spots at the end of the cell. In space 2 there is a linear spot slightly basad from the two spots at the end of the cell. All spots white hyaline. Fringes slightly lighter than the ground color.

MALE (Under Side). Primaries brown. All spots reappear and are well defined. There is an extra, linear, spot in space 11, extending outward from the cell spot directed toward the apical spot in space 8.

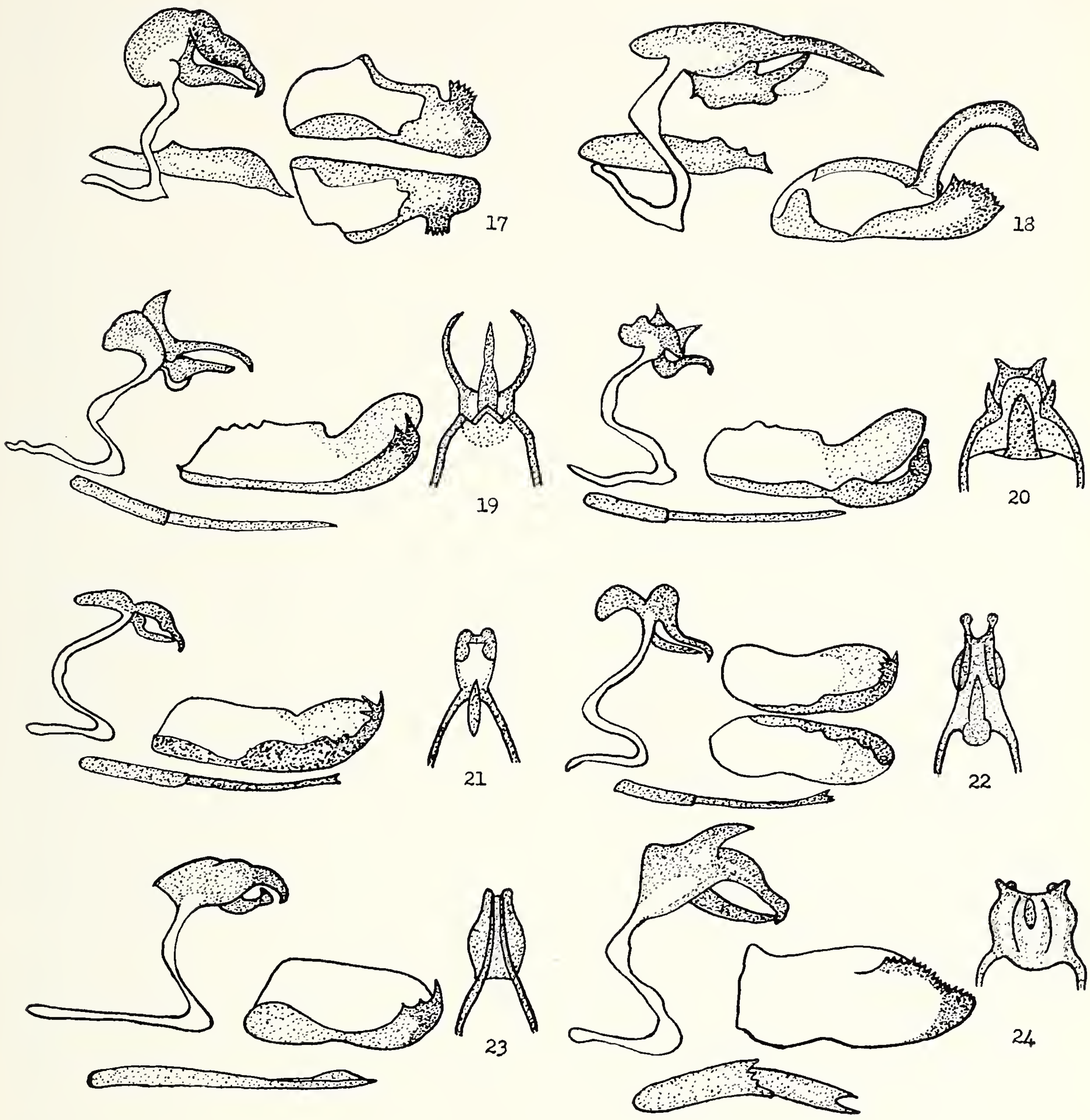
Secondaries brown. There are seven submarginal spots, extending from space 1c to space 6. There is a well developed, oval, cell spot, and a double spot at the end of the cell. There is a discal spot in space 2 and also in space 1b. In space 7 there is an elongated spot extending from the outer edge of the top double spot at the end of the cell to near the submarginal spot in space 6.

Thorax above dark brown, slightly lighter beneath. Abdomen dark brown above, slightly lighter beneath. Head dark brown. Palpi sordid white. Legs brown. Antennae, shaft dark brown, club, basal half brown, terminal half yellow above; beneath, shaft tan, club yellowish.

WING MEASUREMENTS. Primaries; base to apex, 11 mm; apex to outer angle, 6.5 mm; outer angle to base, 11 mm. Secondaries; base to end of vein 3, 8.5 mm; center of costa to anal angle, 8 mm. Total expanse: 22 mm.

TYPE MATERIAL. Holotype, male, Milpillas, Guerrero, Mexico, 6 July 1956, collected by Kent Wilson, will be placed in the American Museum of Natural History, New York.

This species is a member of the *cingo* complex. In general appearance it resembles *P. aea* (Dyar) but differs distinctly in four ways: (1) the spots are much better developed in **milpa**, both above and below, than in *aea;* (2) the spot in space 7 on the lower surface of the secondaries places **milpa** in the *cingo* complex as it extends from directly above the double spots at the end of the cell to just inside the spot in space 6, while in *aea* this spot is small and located directly over the double spots at the end of the cell thus placing it in the *microsticta* complex; (3) the veins are lighter than the ground color on the under side of the primaries of *aea*, while this is not the case in **milpa**; and (4) differences in the genitalia.



Figs. 17–24. Male genitalia. 17. *Urbanus* **viridis**, n. sp., Holotype, Fortin de los Flores, Veracruz, Mexico, 15 August 1967 (H. A. Freeman; A.M.N.H.). 18. **Zobera albopunctata**, n. gen. and sp., Paratype, Salada, Colima, Mexico, 13 June 1967 (Robert Wind; H.A.F.). 19. *Piruna* **maculata**, n. sp., Paratype, Sinaloa, Durango-Villa Union Highway, Rt. 40, Mexico, 29 April 1966 (Peter Hubbell; A.M.N.H.). 20. *Piruna* **sina**, n. sp., Paratype, Sinaloa, Durango-Villa Union Highway, Rt. 40, Mexico, 29 April 1966 (Peter Hubbell; H.A.F.). 21. *Piruna* **ajijiciensis**, n. sp., Paratype, Ajijic, Jalisco, Mexico, 3 October 1965 (Robert Wind; H.A.F.). 22. *Piruna* **milpa**, n. sp., Holotype, Milpillas, Guerrero, Mexico, 6 July 1956 (Kent Wilson; A.M.N.H.). 23. *Amblyscirtes* **immaculatus**, n. sp., Paratype, Salada, Colima, Mexico, 10 June 1967 (Robert Wind; H.A.F.). 24. *Aedes* **brilla**, n. sp., Holotype, Catemaco, Veracruz, Mexico, January 1953 (Tarsicio Escalante; A.M.N.H.).

Amblyscirtes **immaculatus**, n. sp.

Figs. 13, 14, 23

MALE (Upper Side). Primaries dark brown, immaculate except for the slightest indication of apical spots in spaces 6, 7, and 8. There is a narrow, slightly broken, black stigma extending from space 1 to the end of the cell. Fringes checkered, dark brown and sordid white.

Secondaries dark brown, immaculate. Fringes slightly checkered, tan and clear white.

MALE (Under Side). Primaries brown, with scattered gray overscaling near the apex. There are three apical spots faintly indicated.

Secondaries dark brown, sparsely overscaled with gray. There are three very indistinct, grayish, discal spots, otherwise immaculate.

Thorax dark brown both above and below. Abdomen dark brown above, grayish below. Head brown. Palpi grayish-brown. Antennae, shaft brown above and below; club, basal half grayish above, white below, terminal end and apiculus black above, lighter below with the apiculus being tan.

WING MEASUREMENTS: Primaries; base to apex, 18 mm; apex to outer angle, 12 mm; outer angle to base, 19.5 mm. Secondaries; base to end of vein 3, 14 mm; center of costa to anal angle, 13 mm. Total expanse: 36 mm.

TYPE MATERIAL. Holotype, male, Salada, Colima, Mexico, 4 June 1967, collected by Robert Wind, will be placed in the American Museum of Natural History, New York. There are three male paratypes: two were collected by Robert Wind at the same location, one 10 June 1967, and one 19 June 1967, and are in the H. A. Freeman collection; and one from Acahuizotla, Guerrero, Mexico, July 1960, obtained from Dr. Tarsicio Escalante and will be placed in his collection.

This new species belongs in Evan's Exoteria Group and flies in company with *folia* Godman, from which it can be separated by the following differences: (1) the absence of spots on the primaries both above and below in **immaculatus**, while *folia* has well developed maculation on the primaries; (2) in *folia* there is a suffused white discal area in space 1b on the lower surface of the primaries which is not present in **immaculatus**; (3) on the lower surface of the secondaries in *folia* there are clear white discal and cell spots which are absent in **immaculatus** or only slightly indicated; (4) the stigma is broader and slightly shorter in *folia* than in **immaculatus**; and (5) there are differences in the genitalia.

Aedes **brilla**, n. sp.

Figs. 15, 16, 24

MALE (Upper Side). Primaries dark brown, heavily overscaled with golden scales near the base. There are four slightly yellowish, hyaline spots present; one in the cell, one in space 1b directly under the cell spot, a broadly triangular spot in space 2 slightly outward from the spot in the cell and the one in space 1b, and one in space 3 outward from the one in space 2. There are long brands on both sides of veins 1 and 2, and below the cubitus. Fringes narrow and clear white.

Secondaries dark brown, heavily overscaled with golden, hair-like scales near the base. There is a minute yellow spot in space 4. Fringes narrow and clear white.

MALE (Under Side). Primaries dark brown over the discal and basal areas, ferruginous over the apical third of the wing. All spots reappear and are more yellowish in coloration. The spot in space 1b is broader than above and yellowish-white. There is a small costal spot above the cell spot.

Secondaries deep chocolate brown, overscaled below the costal and apical regions with ferruginous scales. There is a broad central, silvery spot, extending from 1c to the lower half of the cell. In space 2 there is a small silvery spot, and another slightly smaller, silvery spot near the end of the cell.

Thorax golden brown above, darker brown below. Abdomen slightly golden brown above, darker brown below. Head dark golden brown. Palpi yellow. Legs dark brown. Antennae missing.

WING MEASUREMENTS: Primaries; base to apex, 23 mm; apex to outer angle, 15 mm; outer angle to base, 15 mm. Secondaries; base to end of vein 3, 13 mm; center of costa to anal angle, 16 mm. Total expanse: 44 mm.

TYPE MATERIAL. Holotype, male, Catemaco, Veracruz, Mexico, January 1953, obtained from Dr. Tarsicio Escalante, Mexico, D. F., will be placed in the American Museum of Natural History, New York.

The brand arrangement on the upper surface of the primaries places this species in the *epitus* complex, however the general maculation is very similar to *aegita* (Hewitson) which has the brands present only as small dark spots on either side of the base of vein 2 and only above vein 1. In comparing the brands see Godman & Salvin, pl. 96, figs. 22 and 23, for male venation and genitalia of *epitus* (Stoll), and for *aegita* (Hewitson) see male with venation and genitalia figured by Godman & Salvin, pl. 96, figs. 27–30 as *ocrinus* (Plotz) which actually represents *aegita*.

This specimen was recorded as *aegita* (Hewitson) as representing a new skipper record for Mexico by me, Journ. Lepid. Soc., Vol. 20, No. 4, Nov. 1966, p. 228, and I would like to remove that name from our list of Mexican Hesperiidae.

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North American Crambinae: Notes on the Tribe Chiloini and a Revision of the Genera *Eoreuma* Ely and *Xubida* Schaus (Lepidoptera: Pyralidae)

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Abstract: The tribe Chiloini of the pyralid subfamily Crambinae is characterized and its North American genera and species listed. The North American species of the chiloine genera *Eoreuma* Ely and *Xubida* Schaus are characterized and discussed, and their male genitalia figured. The following new species are named: *Eoreuma* **evae** (Arizona), **confederata** (Texas), **callista** (New Mexico), and **crawfordi** (Iowa); and *Xubida* **relovae** (Florida) and **lipan** (Texas). A **neotype** is designated for *Spermatophthora multilineatella* Hulst, here placed in *Xubida*.

The writer is preparing a monograph of the North American Crambinae which, however, cannot be ready for publication for at least a year. It is desirable that in the meantime names be available for a number of undescribed species, for the benefit of other workers in the field who are studying the tropical Crambinae. Furthermore, the status of the tribe Chiloini and of the two genera treated here need clarification.

TRIBE CHILOINI

Until relatively recently the wing venation has been used as the chief generic criterion in the Crambinae. A number of genera have been more or less set apart on the basis of having vein R_5 (forewing) arising from the end of the discal cell, instead of being stalked with R_{3+4} as in most other genera. This character is, indeed, valid for most of the presently recognized Chiloini, but not for all. For example, Barnes & McDunnough named *Crambus chiloidellus* in the genus *Crambus* Fabricius because it has R_5 short-stalked on R_{3+4}, but in all other ways it is unmistakably a member of the Chiloini. Dyar named *Platytes vobisne* in the genus *Platytes* Guenée, which he considered (mistakenly) to be in the group of genera we now consider chiloine, because it has R_5 arising from the cell; but in all other ways this species is crambine and not chiloine.

Acknowledgment is made of the cooperation of every museum and major collection in North America and of the British Museum (Natural History) in lending material for study. Many individuals, too, have been most helpful, especially Andre Blanchard, Stanislaw Bleszynski, Mont Cazier, Clifford Crawford, Douglas Ferguson, Willis Gertsch, E. C. Heinrichs, J. R. Heitzman, Charles Kimball, Bryant Mather, and Ellis Matheny.

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In addition the genera *Argyria* Hübner and *Urola* Walker in North America (and others in the tropical regions) have R_5 from the cell, but are so distinctive in genitalia, palpi and other features that they stand apart from both the Crambini and the Chiloini. The Chiloini may be briefly characterized as follows:

> Head with frons rounded to conical and tuberculate. Forewing with vein R_5 almost always from discal cell below R_{3+4}. Ocelli and chaetosomata sometimes absent. Labial palpi almost always three or more times the head length. Male genitalia with juxta usually well developed, often with long, sclerotized, paired, caudolateral extensions; pseudosaccus often absent, if present not long and tubular; saccus of valva little developed, without strong, sclerotized processes; valvae without groups of greatly enlarged setae. Female genitalia with papillae anales strong, not bilobed, strongly compressed, each supported by a transverse, sclerotized, dorsoventral bar at posterior end of the apophysis posterior; apophyses posteriores well developed, sometimes very long, often partly strongly flattened and expanded; apophyses anteriores well developed and strong. Pattern of forewing most frequently with longitudinal streaks between, and sometimes along veins; transverse markings often vestigial or absent, when present usually consisting of rows of spots along median-postmedian (m-pm) and submarginal (sm) lines. Larvae often borers in soft, monocotyledonous stems.

As delimited here the Chiloini are a worldwide group with a considerable representation in the Holarctic region, but with far more tropical genera and species. In North America nearly all of the species are limited to the southern parts and belong to genera more abundantly represented and more widely distributed in the tropics. Very few occur as far northward as southern Canada and only one, *Acigona comptulatalis* (Hulst) has a boreal distribution, occurring only in southern Canada and the northern United States.

GENERIC CLASSIFICATION, *Chiloini*

The chiloine generic classification is quite confused, having for long been based on such externally visible characters as venation, palpi, ocelli and shape of the frons which we now know to be largely unreliable for tribal and generic classification, although they may be valuable in species-level taxonomy. Hampson (1896) made the first detailed classification of the world genera, using chiefly venation. Forbes (1923 and 1926) did about as well as possible without studying the genitalia. Dyar and Heinrich (1927) studied the genitalia but published on only a part of the group, omitting the genera with veins R_1 anastomosing or fusing with Sc, and R_5 stalked with R_{3+4}. In recent years Bleszynski has made a very detailed study of the world fauna, publishing a large number of articles, in the course of which his ideas of the generic classification have altered greatly, chiefly in the direction of temporary generic lumping. There is thus no "standard" classification based on a worldwide study. The present author feels that no useful purpose will be served by proliferating genera based on a limited faunal study, especially when the Neotropical region is still comparatively unknown. The following listing shows his ideas about the taxonomy of the North American chiloine fauna, using generic names already available.

EPINA Walker, 1866, type species *Epina dichromella* Walker, 1866. 1. *dichromella* Walker. 2. *alleni* (Fernald) 1888.

CHILO Zincken, 1817, type species *Tinea phragmitella* Hübner, 1805. 1. *plejadellus* Zincken, 1821. 2. *erianthalis* Capps, 1963. 3. *idalis* (Fernald) 1896.

THOPEUTIS Hübner, 1818, type species *Thopeutis respersalis* Hübner, 1818. 1. *forbesellus* (Fernald) 1896.

ACIGONA Hübner, 1825, type species *Tinea cicatricella* Hübner, 1824. 1. *comptulatalis* (Hulst) 1886.

DIATRAEA Guilding, 1832, type species *Phalaena saccharalis* Fabricius, 1794. 1. *saccharalis* (Fabricius). 2. *crambidoides* (Grote) 1880. 3. *venosalis* Dyar, 1917. 4. *evanescens* Dyar, 1917. 5. *grandiosella* Dyar, 1911. 6. *lineolata* (Walker) 1856. 7. *lisetta* (Dyar) 1909.

HAIMBACHIA Dyar, 1909, type species *Crambus placidellus* Haimbach, 1907. 1. *squamulella* (Zeller) 1818. 2. *arizonensis* Capps, 1965. 3. *pallescens* Capps, 1965. 4. *indistinctalis* Capps, 1965. 5. *discalis* Dyar & Heinrich, 1927. 6. *floridalis* Capps, 1965. 7. *albescens* Capps, 1965. 8. *placidella* (Haimbach). 9. *cochisensis* Capps, 1965. 10. *diminutalis* Capps, 1965.

EOREUMA Ely, 1910, type species *Chilo densellus* Zeller, 1881. 1. *densella* (Zeller). 2. *loftini* (Dyar) 1917. 3. **evae**, n. sp. 4. **confederata**, n. sp. 5. *multipunctella* (Kearfott) 1908. 6. **callista**, n. sp. 7. **crawfordi**, n. sp.

XUBIDA Schaus, 1927, type species *Xubida dentilineella* Schaus, 1922. 1. *linearella* (Zeller) 1863. 2. *panalope* (Dyar) 1917. 3. **relovae**, n. sp. 4. *punctilineella* (Barnes & McDunnough) 1913. 5. **lipan**, n. sp. 6. *dentilineatella* (Barnes & McDunnough) 1913. 7. *puritella* (Kearfott) 1908. 8. *chiloidella* (Barnes & McDunnough) 1913.

HEMIPLATYTES Barnes & Benjamin, 1924, type species *Diatraea epia* Dyar, 1912. 1. *epia* (Dyar). 2. *prosenes* (Dyar) 1912. 3. *parallela* (Kearfott) 1908.

EUFERNALDIA Hulst, 1900, type species *Eufernaldia argentinervella* Hulst, 1900. 1. *cadarella* (Druce) 1896.

The generic name *Platytes* Guenée was used for so many Chiloini by Hampson, Dyar, Barnes & McDunnough and Forbes that its absence here requires comment. Its type species is the Palaearctic *Tinea cerussella* Denis & Schif-

→

EXPLANATION OF FIGURES

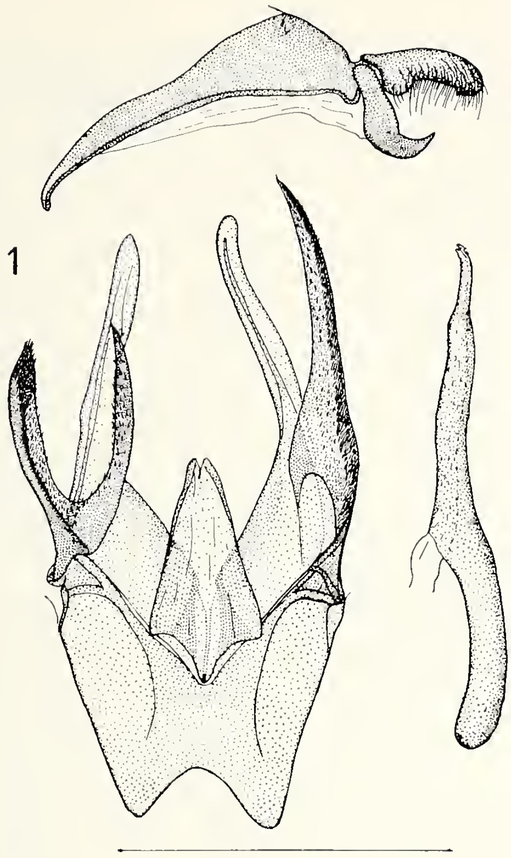
The uncus, gnathos, tegumen and aedoeagus are shown in lateral aspect, the vinculum, juxta and valvae in dorsal view, the valvae somewhat spread laterad. The scale lines represent 1 mm. on the specimen.

Fig. 1. *Eoreuma densella* (Zeller), Key Largo, Florida.

Fig. 2. *Eoreuma loftini* (Dyar), Mesa, Arizona.

Fig. 3. *Eoreuma* **evae**, n. sp., holotype, Madera Canyon, Santa Rita Mts., Arizona.

Fig. 4. *Eoreuma* **confederata**, n. sp., holotype, Limpia Canyon, Jeff Davis Co., Texas.



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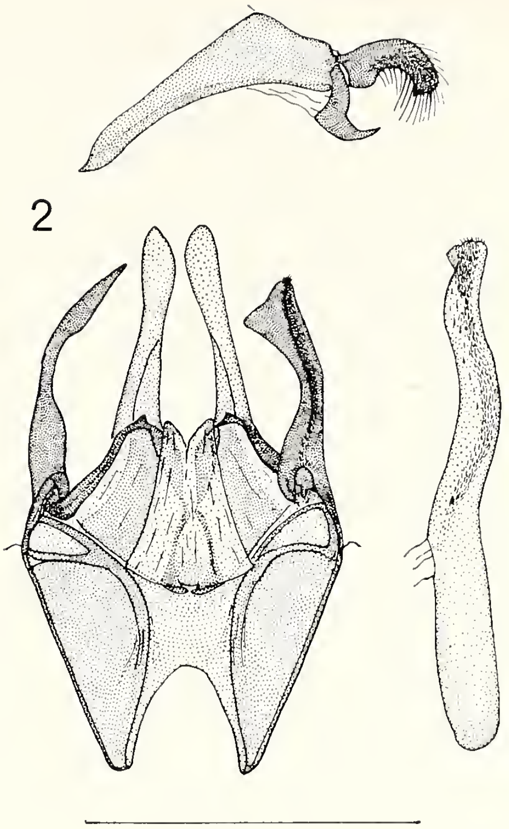

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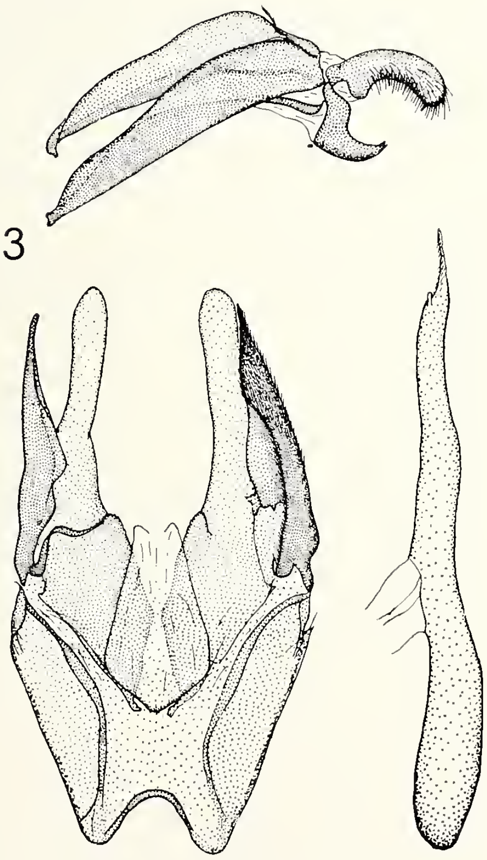

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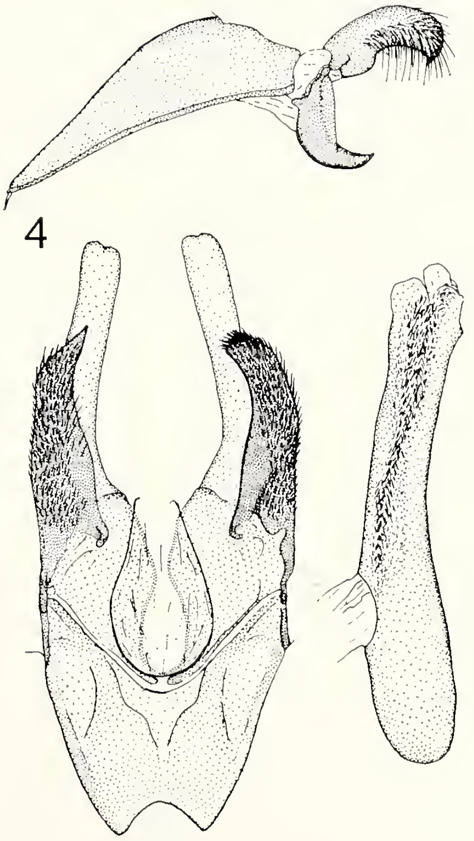

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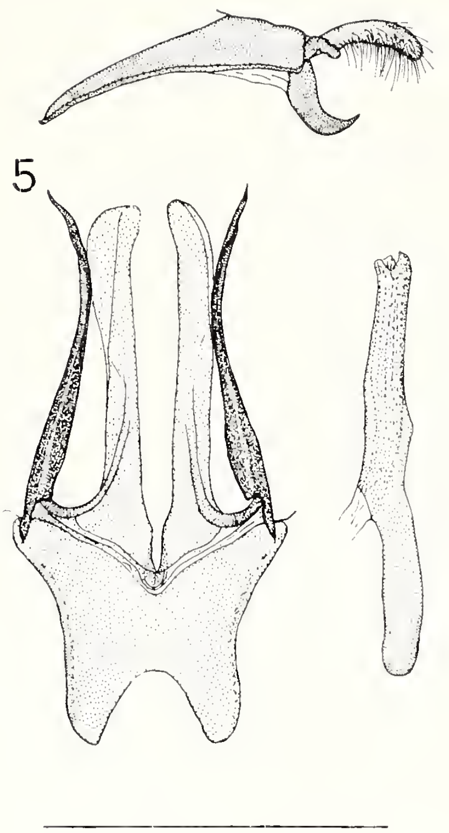

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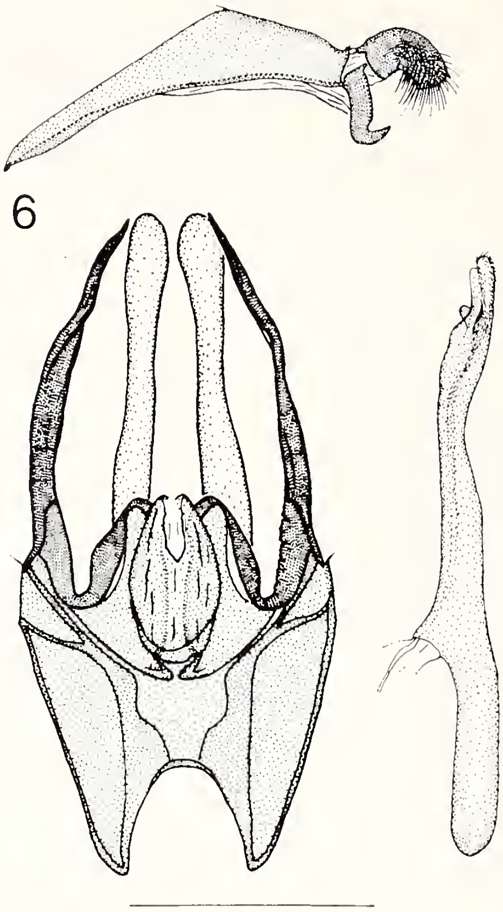

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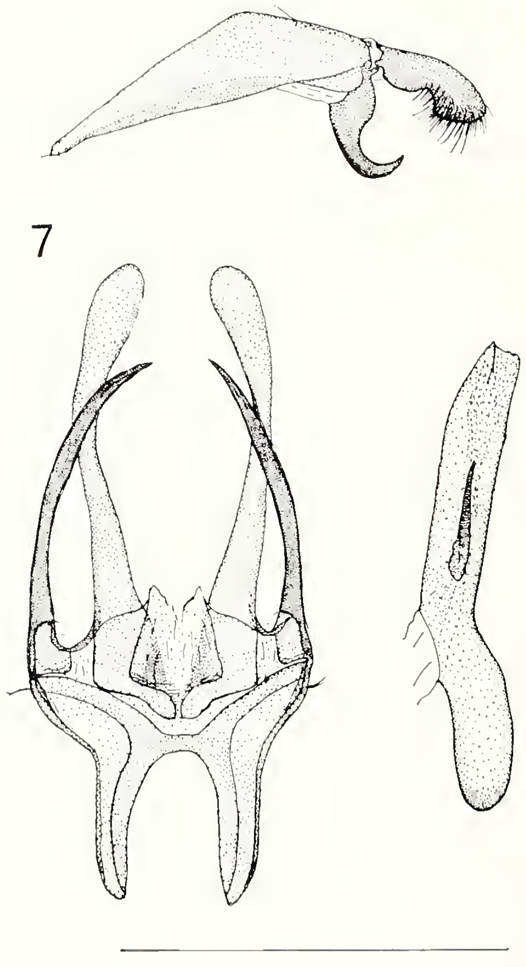

7

fermüller, 1775, designated by Hampson, 1896, p. 947. Examination of the genitalia and venation of *P. cerusellus* shows that it is unmistakably a member of the Crambini, not the Chiloini, and that no known North American species can possibly be placed in it.

ABBREVIATIONS: The names of institutions in which type material is located have been abbreviated as follows: A.M.N.H., American Museum of Natural History; A.S.U.T., Arizona State University, Tempe; B.M., (British Museum [Natural History]); C.N.C., Canadian National Collection; C.U., Department of Entomology, Cornell University; I.S.U., Iowa State University; L.A.C.M., Los Angeles County Museum; N.M.W., Naturhistorisches Museum, Wien; U.S.N.M., U. S. National Museum.

EOREUMA Ely, 1910, Proc. Ent. Soc. Washington, **12**:204

Type species: *Chilo densellus* Zeller, 1881, by monotypy.

The species here included in *Eoreuma* form, on the whole, what looks like a natural grouping, but this depends on what characters one considers more important. They agree in having the uncus and gnathos characteristically strongly opposingly curved and the areas along the veins of the forewings white; while the species placed in *Xubida* have the uncus and gnathos flattened, long and almost straight and the veins marked with dark lines. Both types of uncus and gnathos are found in *Diatraea, sensu lato,* while the *Eoreuma* type occurs in a number of other genera, e.g., *Haimbachia.* On the other hand the *Eoreuma* species form two distinct groups, if judged by the characters of the valvae (cf. Figs. 1–4 & 5–7); and in this respect (but not in uncus–gnathos structure and pattern) *E.* **crawfordi**, *multipunctella* and **callista** could be grouped with *Xubida puritella* and *chiloidella.*

The genus may be characterized as follows: uncus more or less cylindrical or somewhat compressed, with an enlarged, transverse basal portion, curving strongly ventrad, distally blunt with, usually, a ventral subterminal tooth; gnathos similarly short and heavily sclerotized, tapering strongly to a sharp, usually bifid, point, curved strongly dorsad; tegumen with long, thin, diagonal pedunculi that have their caudal margins bent strongly mesad; juxta a simple, troughlike support beneath aedoeagus, not heavily sclerotized, without paired, caudolateral arms; costal processes of valvae long and strongly sclerotized; no more than one (sometimes none) subbasal process of valva; frons rounded or conical; ocelli and chaetosomata present; pattern with veins white and darker intervenous areas containing longitudinal dark lines or shades; transverse markings vestigial or absent.

←

Fig. 5. *Eoreuma* **crawfordi**, n. sp., holotype, Ames, Iowa.

Fig. 6. *Eoreuma multipunctella* (Kearfott), Huachuca Mts., Arizona.

Fig. 7. *Eoreuma* **callista**, n. sp., paratype, Laguna, New Mexico.

KEY TO NORTH AMERICAN *Eoreuma* BY EXTERNAL CHARACTERS

1. Frons conical 2
   Frons rounded 3
2. General color of forewing brown; usually a small dark discal dot; intervenous spaces brownish, usually with few darker scales but sometimes with darker brown scales margining whitish areas along veins; California and Arizona; 9.6–11.4 mm. .... *E. loftini*
   General color of forewing grayer; seldom more than a trace of a discal dot; intervenous spaces tending more to be edged with fuscous scales margining whitish areas along veins; southern Arizona; 9.8 mm. (very small male)—15.4 mm. (very large female) .... *E. multipunctella*
3. Markings of forewing contrasting and clear-cut; veins broadly satiny white; intervenous spaces clear, light yellow, marked only by single rows of blackish scales forming almost complete lines margining each white venous area; no dark discal dot, each discocellular vein white like other veins; southern New Mexico & Arizona; 8.9–9.1 mm. .... *E.* **callista**, n. sp.
   Markings more diffuse; veins more narrowly white or whitish; intervenous spaces diffusely brownish; if markings are relatively clear-cut and contrasting (*E. densella*, dark specimens) then with a prominent dark discal dot 4
4. Forewing with terminal line, if present, very weak, but a series of distinct terminal dots in cells R_5–Cu_{1b}); R_2 stalked on R_{3+4} (vide infra); markings, especially of dark specimens, relatively clear-cut, with veins distinctly white and discal dot sharp and black; Massachusetts and North Dakota to Florida and Texas; 5.9 mm. (minute male)—11.4 mm. (very large female) .... *E. densella*
   Forewing with a thin, dark terminal line, only very rarely with faint terminal dots; R_2 from cell; markings relatively diffuse, veins not contrastingly lighter; discal dot, if present, diffuse, not contrasting 5
5. Forewing with apex acuminate; discal dot definite, although diffuse; Iowa & Manitoba; 8.1–8.3 mm. (two males) .... *E.* **crawfordi**, n. sp.
   Forewing with more normal, blunter apex; no discal dot 6
6. General color of forewing pale, slightly olivaceous gray; subcostal edge broadly pale, almost unmarked in area of radial branches; intervenous areas with many separate, contrastingly dark scales mostly forming lines outlining white venous areas; western Texas; 11.9 mm. (one male) .... *E.* **confederata**, n. sp.
   General color of forewing distinctly brownish; subcostal edge with distinct brown lines outlining intervenous spaces; intervenous dark areas with few, if any, distinct and separate dark scales; southern Arizona; 10.0 mm. (one male) .... *E.* **evae**, n. sp.

KEY TO NORTH AMERICAN *Eoreuma* BY MALE GENITALIA

1. Costal processes of valvae thick, asymmetrical, at least partly densely spiculate 2
   Costal processes of valvae long and thin, symmetrical, with no densely spiculate areas 5
2. Dextral costal process deeply bifurcate, sinistral one simple .... *E. densella*
   Both costal processes simple 3
3. Both costal processes with densely spiculate areas .... *E.* **confederata**, n. sp.
   Only the sinistral costal process with dense spiculation 4
4. Sinistral costal process terminally truncate with a meso-ventrad pointing lobe .... *E. loftini*
   Sinistral costal process tapering to a simple, sharp point .... *E.* **evae**, n. sp.
5. Vinculum very deeply emarginate cephaloventrally; aedoeagus with a strong cornutus .... *E.* **callista**, n. sp.
   Vinculum more shallowly emarginate cephaloventrally; aedoeagus with no cornuti 6

6. Valva with a rounded, setose lobe near ventral margin, from which a thin, sclerotized keel projects dorsad; costal processes weakly sinuate, extending little, if any, caudad of ends of cuculli; aedoeagus with a pair of small, projecting lobes terminally; a spheroid corematal structure middorsally at caudal edge of segment three of abdomen .... *E. multipunctella*

Valva with no ventral lobe; costal processes evenly curved laterad, caudally exceeding ends of cuculli; aedoeagus with no projecting terminal lobes; no corematal structures on segment three of abdomen .... *E.* **crawfordi**, n. sp.

Eoreuma densella (Zeller)

Fig. 1

Chilo densellus Zeller, 1881, Horae Ent. Soc. Rossicae, **16:** 158, pl. 11, fig. 2.

E. densella is widespread, often relatively common southward, but scarcer or more local northward. Northern specimens average paler and more lightly marked than southern ones. In dark specimens the narrow, white discal streaks running distad from the discal cell in cell M_1 and along the fold are often very distinctly white and edged with black scales that contrast with the dark brown scales forming the other dark markings. The asymmetry of the costal processes of the valvae is constant, but there is considerable variation in the relative lengths of the two arms of the dextral one. The plain, more ventral process is usually shorter than the setose, more dorsal one, but occasionally is the longer. No correlation has been found between such variations and geographic distribution. Vein R_2 is stalked on R_{3+4} in all of the 132 specimens studied except in seven of 12 abnormally large males from near Sarasota, Florida in which it arises from the cell well basad of the base of R_{3+4}.

TYPE MATERIAL. Type ♂, Texas (in B.M.).

GEOGRAPHIC DISTRIBUTION. Connecticut, Florida, Georgia, Illinois, Iowa, Massachusetts, Michigan, Mississippi, New York, North Carolina, North Dakota, Tennessee, Texas.

Eoreuma loftini (Dyar)

Fig. 2

Chilo loftini Dyar, 1917, Insecutor Inscitiae Menstruus, **5:** 85.
Chilo opinionellus Dyar, 1917, *Ibid.*, **5:** 84.

These two nominal species were described by Dyar from single specimens of different sexes reared from different foodplants. However, study of additional specimens shows that they are almost certainly conspecific.

TYPE MATERIAL. *loftini*, type ♀, No. 21128, Glendale, Arizona, 1 Sept. 1914, bred from "Mexican cane," U. C. Loftin (in U.S.N.M.); *opinionellus*, type ♂, No. 21180, Yuma, Arizona, 24 July 1916, bred from larva in wheat stem, T. D. Urbahns (in U.S.N.M.).

GEOGRAPHIC DISTRIBUTION. Southern Arizona, southern California; probably Mexico: Sinaloa, Yucatan.

Eoreuma **evae**, n. sp.

Fig. 3

Forewing length, 10 mm. Frons bulging but rounded. Head and thorax pale brownish white, slightly mottled with darker brownish. Forewing ground color pale brownish white, intervenous spaces mostly darker, pale brownish with a sparse sprinkling of slightly darker brown scales along their edges, and a slightly heavier concentration of dark scales along the fold; intervenous spaces somewhat darker and more completely dark shaded in area between discal cell and costal margin. No dark discal dot. A dark terminal line on both forewings and hind wings; hind wings slightly paler than forewings.

MALE GENITALIA. Uncus and gnathos normal for the genus. Mesad-folded part of tegumen broad and heavily sclerotized. Vinculum deeply emarginate ventrocephalically. Costal processes of valva large, heavily sclerotized, asymmetrical, the sinistral one sharply acute with a heavily spiculate area from base to tip, the dextral one about equal in length, very sparsely setose. Ventro-mesal process of valva very small, scarcely protruding. Juxta large but lightly sclerotized. Aedoeagus long and thin, longer than vinculum + valva, slightly sinuate, tapering caudad, with a very small, rounded, dorso-sinistral lobe at tip; vesica with no cornuti, with very sparse, very minute spicules in a small area.

Although only a single specimen is known, *E.* **evae** is clearly a distinct species by the male genitalia, since in the group to which it belongs these structures show constant differences between species and very little individual variation. It is named appreciatively for Mrs. Stanislaw Bleszynski.

TYPE MATERIAL. Holotype ♂, Madera Canyon, Santa Rita Mts., southern Arizona, 19 Aug. 1953, leg. Robert J. Ford, genitalia No. 4074—2, S.B. [S. Bleszynski] (in C.N.C.).

Eoreuma **confederata**, n. sp.

Fig. 4

Forewing length, 11.9 mm. Frons rounded. Labial palpi long and thin, ratio of length (with vestiture) to diameter of eye, 5/1, with closely appressed vestiture of long scales, most of which have a short, dark brown, subterminal or terminal band contrasting sharply with the very pale brownish ground color. Maxillary palpi pale, creamy white with a few dark-tipped scales externally. Forewing very pale creamy white, lines along veins concolorous, unmarked; intervenous spaces marked with irregular rows of contrasting, dark brown tipped scales, somewhat concentrated along margins between intervenous spaces and light venous areas; area from discal cell and R_{3+4} to costal margin almost unmarked. Hindwing white, unmarked.

Male Genitalia—Uncus and gnathos normal for the genus. Mesad-folded part of tegumen not unusually broad or heavily sclerotized. Vinculum emarginate ventrocephalically. Costal processes of valvae large, heavily sclerotized, asymmetrical, both with large areas of very dense spicules which are longer caudally, sinistral process broadly rounded terminally, dextral one acute. Ventral processes scarcely protruding, lightly sclerotized and setose. Juxta large, lightly setose. Aedoeagus relatively short and straight, curved slightly ventrad, shorter than vinculum + valva; vesica with a long, dense area of very fine to coarse spiculation; a short, rounded, lightly sclerotized, protruding lobe dorsosinistrally at tip.

Genitalically *E.* **confederata** is most like *E. densella, loftini* and **evae** (Figs. 1–3). The very pale color of the intervenous spaces, sharply and minutely dotted with fuscous, is distinctive.

TYPE MATERIAL. Holotype ♂, Limpia Canyon, Jeff Davis Co., Texas, 20 May 1950, E. C. Johnston, genitalia slide ♂ No. 4431-S.B. (in C.N.C.).

Eoreuma **crawfordi**, n. sp.

Fig. 5

Forewing unusually acuminate, length 6.8–8.4 mm. (two males). Labial palpi very long and thin, ratio of length (with vestiture) to diameter of eye 5.9/1. Head, both pairs of palpi and thorax whitish mottled with dull brown; scales of palpi very long and thin, each with a white tip and a subterminal brown bar. Forewing very pale brownish white, thickly clouded with darker brown scales, veins only slightly lighter. A relatively large, but not contrasting, discal dot. Costal edge narrowly and sharply whitish except at extreme base. Space between discal cell and this costal edge heavily brown shaded. A narrow, darker terminal line along outer margin, and two darker lines in fringe. Hindwing very pale brownish white with a fine, darker terminal line, fringe almost white.

MALE GENITALIA. Uncus relatively thin, without ventral, subterminal tooth, its base strengthened with a ventral, transverse bar rather than a general thickening. Gnathos normal. Mesad-folded caudal edge of tegumen wide and heavily sclerotized. Vinculum deeply emarginate laterally, more deeply ventrocephalically. Costal processes of valva symmetrical, heavily sclerotized, very long, thin and acuminate, not sinuate, curving laterad. A simple, curved bar connecting base of costal process to rest of valva, basal part of valva simple with no processes or special structures. Juxta small, very lightly sclerotized. Aedoeagus almost straight, thin, caecum penis about 2/5, vesica sparsely spinulose, a pair of small, protruding subdorsal terminal lobes.

E. **crawfordi** is a relatively small, fragile, slender, drab species with a general brownish clouding, but scarcely any distinct markings. The forewing is unusually acuminate for males of a species of *Eoreuma.* The genitalia are quite distinctive because of the long, thin, evenly tapering, acute, laterad-curved costal processes and the lack of any distinct valval structures other than these. *E.* **crawfordi** is named for Prof. E. S. Crawford of the University of New Mexico, Albuquerque, whose physiological and ethological work on New Mexican Crambinae is producing most interesting results.

TYPE MATERIAL. Holotype ♂, Ames, Iowa, 25 July 1933, genitalia praep. 18 Nov. 1969, No. 1, A. B. Klots (in U.S.N.M. from Dept. of Entomology, I.S.U.). Paratypes as follows: 2 ♂♂, Ames, Iowa, 16 Aug. 1933 & 16 July 1933 (in I.S.U. & A.M.N.H.); 1 ♂, Man. Canada, July (in Bleszynski collection).

GEOGRAPHIC DISTRIBUTION—Iowa, Manitoba.

Eoreuma multipunctella (Kearfott)

Fig. 6

Chilo multipunctellus Kearfott, 1908, Proc. U. S. Nat. Mus., **35:** 393.

E. multipunctella is known only from the mountain ranges of southern Arizona, where it may be locally common. The type series consisted of 11 specimens from

Oracle (Pinal Co.), southern Arizona and the Huachuca and Chiricahua Mts. It was stated in the original description that a cotype, Cat. No. 11960 was in the U. S. National Museum and the remaining cotypes in the author's collection [whence they went to the Barnes collection and thence to the U.S.N.M.]. However, the specimen in the U.S.N.M. labelled type No. 11960 is a female from the Baboquivera (sic) Mts. which cannot be the type. I therefore designate as lectotype male a specimen, ex Barnes collection, in the U.S.N.M. from the Huachuca Mts. Arizona, leg. Poling, genitalia slide 28 March 1930, No. 2, C.H. [Carl Heinrich].

Males of *multipunctella* have a small, spheroid, invaginated, presumably corematoid structure middorsally on the caudal edge of the 3d abdominal segment. Of the other North American *Eoreuma* only *E. loftini* has a comparable structure, which in *loftini* is more of a short, transverse band.

TYPE MATERIAL. See above.

GEOGRAPHIC DISTRIBUTION. Baboquivari, Chiricahua, Huachuca, Santa Catalina and Santa Rita Mts., southern Arizona. A similar population in northern Mexico may not be conspecific.

Eoreuma **callista**, n. sp.

Fig. 7

Forewing length 8.9–9.1 mm. Palpi, head and thorax white. Frons rounded. Forewing with veins, including the discocellulars, broadly shining white. Intervenous spaces uniform pale yellow with a single, not quite complete, row of very sharply contrasted black dots along margins between intervenous and venous areas. No terminal line or dots. Hind wings white.

MALE GENITALIA. Uncus thick, expanded basally and terminally, more or less compressed, with a ventral, subterminal tooth in some specimens. Gnathos strong and heavily sclerotized, evenly but strongly curved to tip. Tegumen, as usual in genus, with its caudal edge deeply folded mesad. Vinculum strongly produced ventrocephalically and very deeply emarginate. Costal processes symmetrical, long, thin, slightly thickened subterminally, acuminate, sharp, curved ventromesad. A simple, curved bar connecting bases of costal processes to remainder of valva and running caudad. No other valval processes; cucullus long, thin, somewhat spatulate. Juxta small, not heavily sclerotized. Aedoeagus tubular, shorter than vinculum + valva, with one strong cornutus.

E. **callista** is an extremely distinctive species both in color and pattern and in genitalia. The apex of the forewing is somewhat blunter than in other *Eoreuma*. Genitalically it is more like *E. multipunctella* and **crawfordi** in the structure of the valva, but is the only *Eoreuma* to have a cornutus, a structure comparatively rare in Chiloini. In addition to the hypodigm listed below I have seen a specimen, without abdomen, Roswell, New Mexico, 22 August, T. D. A. Cockerell, in B.M.

TYPE MATERIAL. Holotype ♂, Albuquerque, Bernalillo Co., New Mexico, 27 August 1964, at light (C. S. Crawford), genitalia praep. 7 Dec. 1969, A. B. Klots (in A.M.N.H.); allotype ♀, Lordsburg, Hidalgo Co., New Mexico, 4 Aug. 1937 (Herbert Ruckes, Sr.) genitalia praep. 19 March 1965, A. B. Klots (in A.M.N.H.). Paratypes as follows: 2 ♂♂ & 1 ♀, Lordsburg, New Mexico, 4 Aug. 1937 (Herbert Ruckes, Sr.) (in A.M.N.H.); 1 ♂, Laguna, Bernalillo Co., New Mexico (Geo. Willett) (in L.A.C.M.); 1 ♂, Edgewood, Santa Fe Co., New Mexico, 12 July 1969 (M. & E. Roshore) received from Bryant Mather, (in A.M.N.H.); 1 ♂, Portal, Cochise Co., Arizona, 4,700 ft. alt. at light, 1 Aug. 1964 (J. H. Puckle, M. A. Mortenson & M. Cazier) (in A.S.U.T.); 1 ♂, Palo Duro Canyon St. Park, Texas, 15 Apr. 1969, A. & M. E. Blanchard (in Blanchard collection).

GEOGRAPHIC DISTRIBUTION. See above.

XUBIDA Schaus, 1922, Proc. Ent. Soc. Washington, **24**: 140

Type species: *Xubida dentilineella* Schaus, 1922, p. 141, by original designation.

As here delimited *Xubida* consists of a considerable number of neotropical species, including the type species which is known from Guatemala, as well as the North American species dealt with below. *X. dentilineatella* is closer to the tropical group than any of the other North American species and, in fact, may be a recent arrival or introduction. The other North American species form something of a mixed group which may have to be separated into two or more other genera when the very extensive, largely unknown, neotropical fauna has been studied.

The genus may be characterized as follows: uncus and tegumen broad and quite flattened basally, long and almost straight caudally, acuminate, slightly hooked terminally; tegumen with long, thin, tapering pedunculi with their caudal margins folded mesad; juxta simple, not very heavily sclerotized, with no caudolateral extensions; costal processes of valvae large to very large, strongly sclerotized, often separated from rest of valva by a suture; ventrad of costal process on mesal face of valva a "median process," and a more or less distinct "ventral process" on ventral margin; the ventral process may be a development of the sacculus, which is not clearly discernible in so many Chiloini, and the "median process" may be a homolog of the sclerotized median structure, the "clasper," marking an important muscle attachment, found in many groups of Lepidoptera; frons rounded; ocelli and chaetosomata present; pattern mostly of dark lines along and between veins; transverse markings usually vestigial or absent; sometimes the submarginal line is traceable, running out from costa to form a long point beyond the cell, then running dorsobasad with a zigzag to about the middle of the dorsal margin.

KEY TO NORTH AMERICAN *Xubida* BY EXTERNAL CHARACTERS

1. Ground color white to brownish white, pattern almost entirely of dark lines along and between veins; transverse markings, if any, isolated traces of submarginal (sm) and median-postmedian (m-pm) lines 2

Ground color yellowish white to orange yellow, deeper terminally; dark lines along and between veins relatively inconspicuous; m-pm line mostly traceable, enclosing a pointed discal streak, running almost to apex of wing as a dark shade, then slanting dorso-basad to dorsal margin; California and Arizona; 9.2 mm. (small male)—12.2 mm. (large female) .... *X. dentilineatella*

2. A more or less distinct, dark shade running out in discal region from base to just below wing apex, and another below fold from base to outer angle, space between these contrastingly lighter 3

No such shades with lighter area between them 5

3. Sm line present as an even row of dark dots in cells R_4–Cu_{1b}; Florida; 9.8 mm. (small male)—14.0 mm. (large female) .... *X. punctilineella*

No such submarginal row of dots; Arizona 4

4. Veins very narrowly, often indistinctly, lined with dark; lines in intervenous spaces very indistinct, usually only one or two irregular rows of dark scales; veins R_5 arising from discal cell; dark longitudinal shades more marked, space between these often contrastingly whitish; hind wings very dark; dark discal dot often indistinct; 12.7–14.2 mm. .... males, *X. puritella*

Veins more contrastingly dark-lined; lines in intervenous spaces distinct and wider than those along veins; vein R_5 short-stalked on R_{3+4}; dark longitudinal shades less marked, space between discal cell and fold not contrastingly whitish; hind wings not so dark; dark discal dot usually distinct; 9.3–11.0 mm. .... males, *X. chiloidella*

5. Size large, 11–16 mm.; Arizona 6

Size smaller, 6.5–10.5 mm.; Massachusetts and North Dakota to Florida and Texas .... *X. linearella*[1]
X. panalope
X. **lipan**, n. sp.
X. **relovae**, n. sp.

6. Dark lines along and between veins distinct and clear-cut; R_5 short-stalked on R_{3+4} .... females, *X. chiloidella*

Dark lines along and between veins scarcely present, if at all; R_5 from cell below base of R_{3+4} .... females, *X. puritella*

KEY TO NORTH AMERICAN *Xubida* BY MALE GENITALIA

1. Costal process strongly and deeply bifid .... *X. chiloidella*

Costal process simple 2

2. Median process simple, rounded terminally 3

Median process complex; bifid or with strong setae 6

3. Costal process with free part very long and thin, arising from a very small basal part; vinculum with a very long, thin, ventrocephalic, saccus-like extension .... *X. puritella*

Costal process with free part arising from a large, dorsally expanded basal part; vinculum ventrocephalically emarginate 4

4. Costal process short, not extending as far caudad as end of median process .... *X. linearella*

Costal process relatively longer, extending caudad as far as, or farther than, end of median process 5

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[1] These four relatively small, distinctly marked species of eastern and central North America are very difficult to distinguish by color and pattern, although they are easily distinguished genitalically. Generalizations for distinguishing them by color and pattern are given in the text dealing with them (see below).

5. Costal process strongly curved mesad and ventrad, especially terminally ---- *X. punctilineella*
   Costal process curved dorsad and somewhat laterad ---- *X.* **lipan**, n. sp.
6. Median process with a group of short, strong setae terminally; vinculum rounded ventrocephalically ---- *X. dentilineatella*
   Median process with not more than one projecting spine or tooth terminally ---- 7
7. Median process with a wide, blunt, angulate point extending mesad from tip; costal process flattened and somewhat concave, tapering little, ending abruptly with a mesad hook ---- *X. panalope*
   Median process rounded terminally with a single, small, projecting spur; costal process tapering gradually from base, little flattened, ending in a long, sharp, not hooked point ---- *X.* **relovae**, n. sp.

Xubida linearella (Zeller)
Fig. 8

Crambus linearellus Zeller, 1863, Chilodinarum et Crambidarum, Genera et Species, No. 114, p. 44.

Spermatophthora multilineatella Hulst, 1887, Entomologica Americana, **3:** 134.

The type of *C. linearellus* Zeller, long thought to be lost, recently turned up in the Vienna Museum. Thanks to Dr. S. Bleszynski I have studied the dissection of its genitalia, which permit positive identification. Unfortunately Zeller did not know where it had been collected ("Hab. in America sed in quaejus parte incertum est.") but it is almost certain that it must have come from Florida. Accordingly I designate Florida as the type locality for this nominal species.

The name *multilineatella* Hulst has been generally used for this same species, although many identifications have been faulty because of the unreliability of color and pattern. Hulst described *multilineatella* from two males from Florida. Search of the Hulst collection in the American Museum of Natural History, and of all other collections that might contain Hulst material, including the Museum of Comparative Zoology, Academy of Natural Sciences, Department of Entomology of Cornell University, Carnegie Museum and U. S. National Museum has revealed no trace of either of Hulst's syntypes, which must be presumed lost. It is highly desirable that, in order to stabilize the nomenclature of the species involved, a neotype be designated for *Spermatophthora multilineatella* Hulst. Dr. S. Bleszynski, the only other worker at present active in the New World Crambinae, agrees with this. Accordingly a ♂, Winter Park, Florida, May, 1946, leg. A. B. Klots, genitalia praep. 21 March, 1964, #4 by A. B. Klots (fig. 8) is hereby designated. This specimen is in the American Museum of Natural History, where nearly all surviving Hulst types are located. *S. multilineatella* is to be considered a subjective junior synonym of *C. linearellus* Zeller. The type of *C. linearellus* was not chosen as the neotype of *multilineatella*, which would have made the latter an objective junior synonym, because of its lack of locality data.

X. linearella is relatively common in Florida, elsewhere known only from North Carolina. In color and pattern it is not always easy to distinguish from the likewise common, widespread *X. panalope*, but its markings tend to be a grayer brown and wider and more diffuse; while *panalope* tends to have the intervenous dark line beyond the cell, in cell M_1, lighter than the adjacent intervenous dark lines; the genitalia are very different. Genitalically *linearella* is more like *X. punctilineella* and *X.* **lipan** (see below) differing chiefly in the length of the costal process of the valva (see key). It differs consistently from *punctilineella* in size and color and pattern. On the whole it is most like *lipan.*

TYPE MATERIAL. *linearella*, unique type ♂, "America," genitalia dissected by S. Bleszynski, (in N.M.W.); *multilineatella*, neotype ♂, hereby designated (see above) (in A.M.N.H.).

GEOGRAPHIC DISTRIBUTION. Florida, North Carolina.

Xubida panalope (Dyar)

Fig. 14

Platytes panalope Dyar, 1917, Insecutor Inscitiae Menstruus, **5:** 86–87.
Platytes acerata Dyar, 1917, *Ibid.,* **5:** 86.

In the original descriptions *acerata*, from Florida, was described as darker and more heavily marked than *panalope*, from Connecticut. In general this distinction holds true, northern specimens averaging lighter than southern ones (77 specimens studied by the present writer). However, far more material will have to be studied before any conclusions can be made about a subspecific relationship of these two nominal species. On the basis of color, pattern, venation and male genitalia they appear to be conspecific. As Dyar pointed out the dark intervenous line running from the end of the discal cell to the outer margin is usually lighter than the intervenous lines in the other cells, giving the impression of a pale ray running out from the cell. This is quite noticeable in lightly marked specimens, but is barely, if at all, distinguishable in darker, more heavily marked ones, especially if they are worn. *X. linearella* and *X.* **lipan** do not show this. As also noted by Dyar, vein R_2 is frequently, but not always, stalked with R_{3+4}, a character not noted in other species of the genus. For the

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Fig. 8. *Xubida linearella* (Zeller), neotype of *Spermatophthora multilineatella* Hulst, Winter Park, Florida.

Fig. 9. *Xubida* **lipan**, n. sp., paratype, near Brownsville, Texas.

Fig. 10. *Xubida punctilineella* (Barnes & McDunnough), Port Sewall, Florida.

Fig. 11. *Xubida dentilineatella* (Barnes & McDunnough), Baboquivari Mts., Arizona.

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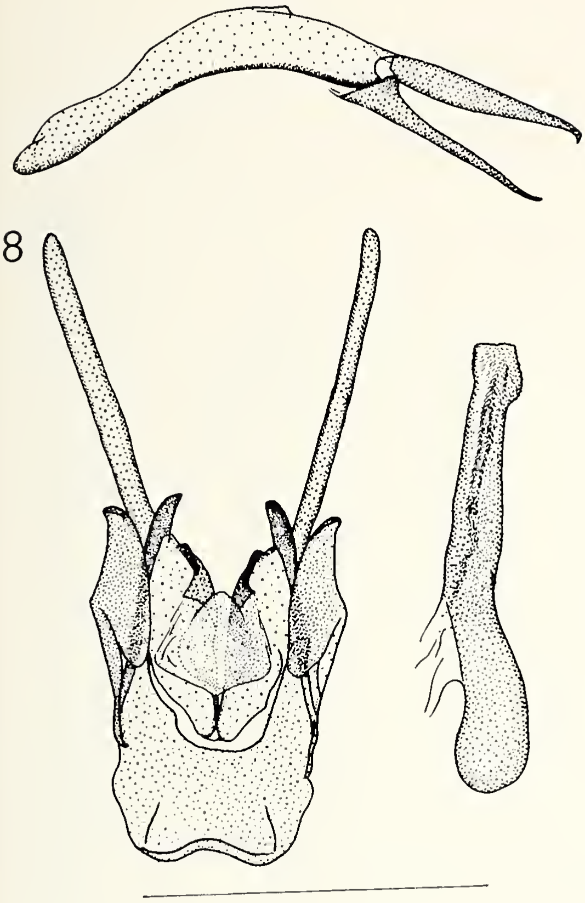

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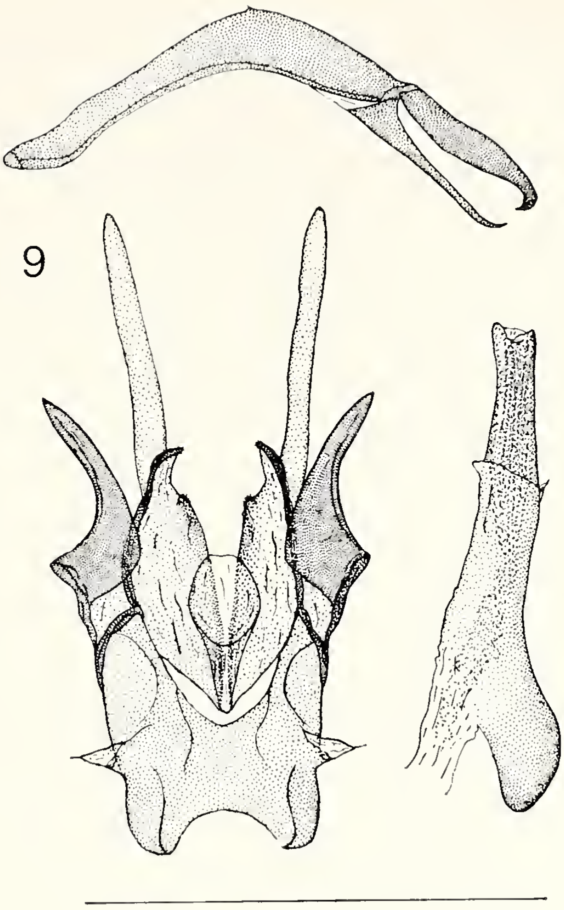

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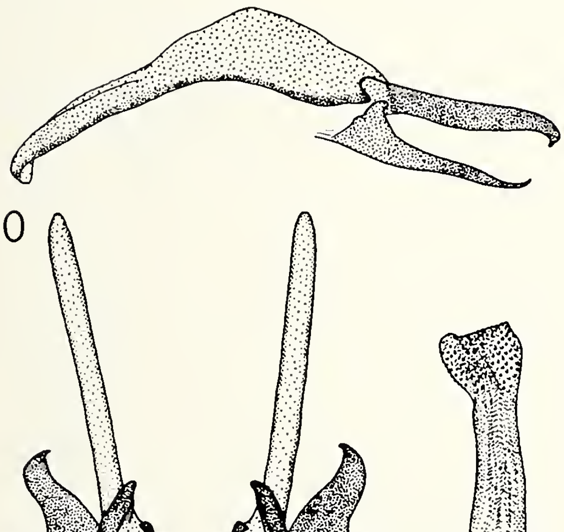

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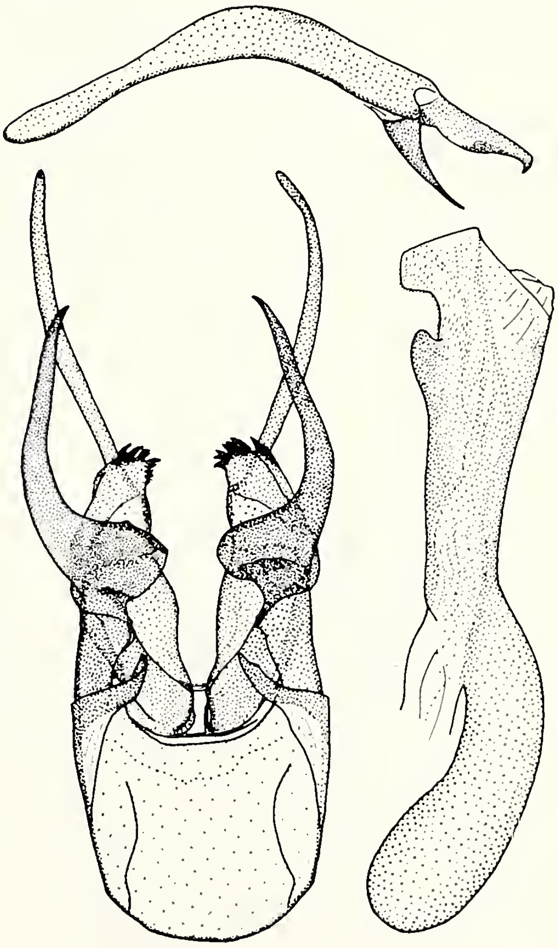

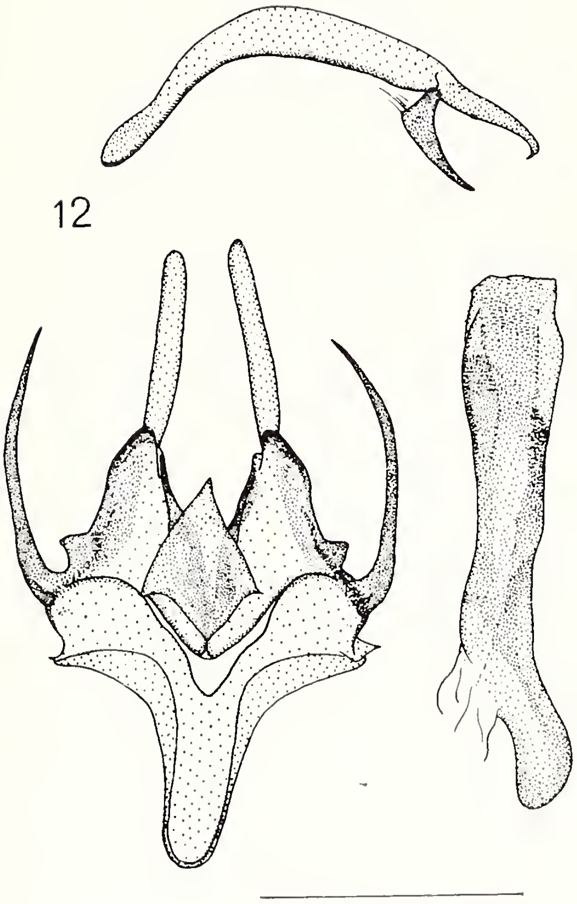
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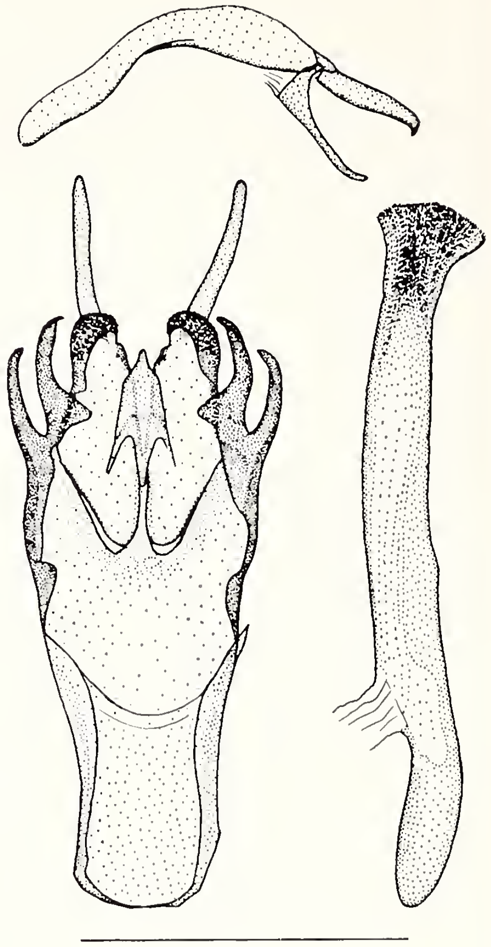
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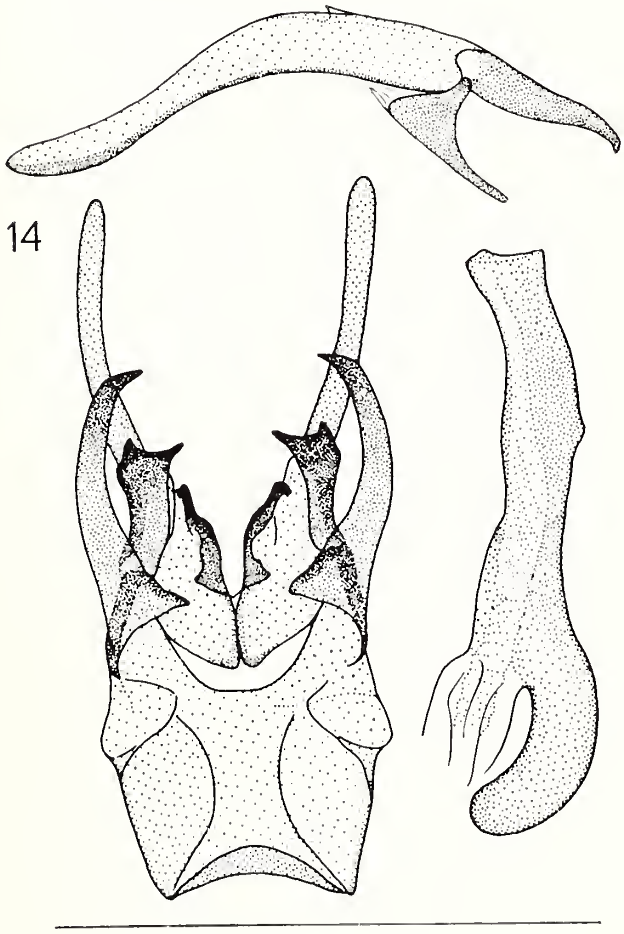
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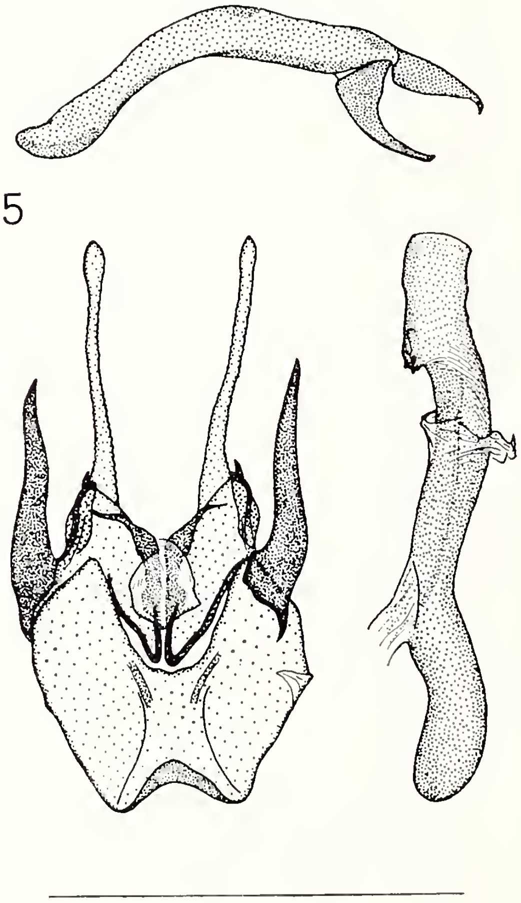
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time being, therefore, it seems best to place *acerata* as a subjective junior synonym of *panalope*, with the realization that in the future it may be raised to subspecific status. The present writer places *acerata* as the junior synonym, even though it has page priority, acting as first reviser under Article 24(a) of the Zoological Code.

TYPE MATERIAL. *panalope*, type ♂, No. 21140, East River, Connecticut, Aug. 1907, Chas. R. Ely, genitalia slide 15 April 1955, No. 10803, H. W. Capps (in U.S.N.M.); *acerata*: type ♂, No. 21147, Dade City, Florida, Sept., J. A. Grossbeck, genitalia slide 5 March 1955, No. 10384, H. W. Capps (in U.S.N.M.).

GEOGRAPHIC DISTRIBUTION. Connecticut, Florida, Iowa, Mississippi, Missouri, New Jersey, Nova Scotia, Texas.

Xubida **relovae**, n. sp.

Fig. 15

Forewing length 8.0 (type) and 7.65 mm. Frons rounded. Labial palpi, ratio of length (with vestiture) to diameter of eye, 3.8/1; vestiture of second segment expanded terminally. Both labial and maxillary palpi light brown laterally, white dorsally. Head white dorsally. Dorsum of thorax and collar white mottled with brown; tegula white with two longitudinal brown lines. Forewing pale brownish white, veins lined with light reddish brown and intervenous spaces centered with light reddish brown lines, those in cells R_4–Cu_{1b} inclusive ending in small, dark marginal dots. A small, but pronounced, dark discal dot. Dark intervenous line in cell M_1 not lighter or more diffuse than those in adjacent cells. Hind wing pale, brownish white.

MALE GENITALIA. Uncus and gnathos relatively very short and wide basally. Vinculum wide, very shallowly emarginate caudolaterally, more deeply so ventrocephalically. Juxta weak, lightly sclerotized. Costal processes of valvae large, long, heavily sclerotized, basally thick, not flattened, tapering gradually to sharp points, slightly sinuate. Median processes well sclerotized, more or less flattened and concave mesally, very weakly setiferous, with a single short, protruding terminal spur. Ventral processes well sclerotized but very small and scarcely protruding, very finely setose. Aedoeagus very large, caecum penis nearly ½ its length; no cornuti.

X. **relovae** is distinguished from *X. panalope* by the relatively shorter uncus and tegumen, the non-flattened, acuminate costal processes and the distinctive median process of the valva which is rounded with a single short, projecting spur. In pattern it is apparently distinguished by the lack of a paler dark marking in cell M_1, but not enough specimens are available to demonstrate this. Occasional specimens of *panalope* have costal processes more like those of **relovae**. The species is named for Miss Carmen Relova,

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Fig. 12. *Xubida puritella* (Kearfott), Portal, Cochise Co., Arizona.

Fig. 13. *Xubida chiloidella* (Barnes & McDunnough), Peña Blanca Canyon, Oro Blanco Mts., Pima Co., Arizona.

Fig. 14. *Xubida panalope* (Dyar), Siesta Key, Sarasota, Florida.

Fig. 15. *Xubida* **relovae**, n. sp., holotype, Port Sewall, Florida.

Scientific Assistant of the Department of Entomology of the American Museum of Natural History, in appreciation of her manifold labors on the Crambinae.

TYPE MATERIAL. Holotype ♂, Port Sewall, Martin Co., Florida, 21 Jan. 1949, genitalia praep. A. B. Klots, 13 March 1956 #3 (in A.M.N.H.); paratype ♂, Biloxi, Mississippi, 13 June 1917, Cornell U. Lot 542, sub. 11, genitalia ♂ 4534, S.B. (in C.U.).

Xubida punctilineella (Barnes & McDunnough)

Fig. 10

Platytes punctilineella Barnes & McDunnough, 1913, Contributions Nat. Hist. Lepidoptera N. A., **2:** 177, pl. 2, fig. 11.

X. punctilineella is distinctive in size, color and pattern and male genitalia, and appears to be limited to Florida. In the size and extent of the costal processes of the valvae it falls into a small group of species with *X. linearella* and *X.* **lipan**.

TYPE MATERIAL. Type ♂, Everglade, Florida, Apr. 8–15, genitalia dissected, R. W. Hodges #3780 (in U.S.N.M.).

GEOGRAPHIC DISTRIBUTION. Central and southern Florida.

Xubida **lipan**, n. sp.

Fig. 9

Forewing length 6.4 mm. (small ♂)—10.2 mm. (large ♀). Frons rounded. Labial palpus, ratio of length to diameter of eye, 4/1. Palpi with outer surfaces brown, dorsal surfaces white. Head white. Collar and tegula white with some brownish mottling. Dorsum of thorax white with some brownish streaking posteriorly. Forewing white, slightly brownish tinged, veins and lines in intervenous spaces dull brown, the veins narrower. A small black marginal dot at the end of each intervenous line in cells M_1–Cu_{1b} inclusive. A small, but distinct, fuscous discal dot. Dark intervenous line in cell M_1 not paler or less conspicuous than lines in adjacent cells. Traces of m-pm line visible, especially as a diagonal line from near costa slanting distad to beyond end of cell, a dark mark in cell M_1 and a broken diagonal line running dorsocaudad from near end of cell, about base of Cu_{1a}, to dorsal margin basad of middle. Hind wing slightly brownish tinged, fringe white.

MALE GENITALIA. Tegumen, uncus and gnathos normal for genus. Vinculum broad, laterocephalically and ventrocephalically emarginate. Juxta very lightly sclerotized. Costal process of valva large, well sclerotized, its basal part large and expanded dorsolaterally, its free process long and thin, far exceeding median process caudally, flat, in normal position curved dorsad. Median process (lying between costal and ventral process) flat, rounded terminally, curved mesad to ventromesad, short, narrow, well sclerotized, terminally irregular with fine setation. Ventral process, lying along ventromesal margin of valva, short, thin, well sclerotized, terminally irregular, with fine setation. Aedoeagus relatively short; no cornuti.

In size, color and pattern *X.* **lipan** most resembles *X. linearella, panalope* and **relovae**. Its dark markings are not as heavy or as diffuse as those of *linearella*, and are more reddish or orange brown. It differs from *panalope* in not having the intervenous space in cell M_1 lighter, and in not having vein R_2 stalked on R_{3+4} as *panalope* frequently does. In male genitalia it is extremely distinct from both *panalope* and **relovae** (see key and Figs. 14 & 15), most so in the median process of the valva. Genitalically it is more like *X. punctilineella* and *linearella;* it differs strongly from the former in color and pattern (see key) and from both in the shape and extent of the costal process of the valva. It may actually be closely related to *X. linearella*, and since the two are allopatric they might be considered conspecific but subspecifically distinct; study of material from the Gulf Coast between Texas and Florida might help to define their relationship.

TYPE MATERIAL. Holotype ♂, Conroe, Montgomery Co., Texas, 27 April 1967, (A. Blanchard) genitalia praep. 27 Jan. 1969, #1, A. B. Klots (in A.M.N.H.); allotype ♀, near Brownsville, Cameron Co., Texas, 26 June 1969 (R. Heitzman) (in A.M.N.H.). Paratypes: 2 ♂♂, Conroe, Texas, 24 Apr. 1962 & 1 May 1966 (A. Blanchard) (in A.M.N.H. & Blanchard collection); 3 ♂♂, near Brownsville, Texas, 25, 26 & 27 June 1969 (R. Heitzman) (in A.M.N.H. & Heitzman collection); 1 ♀, Brownsville, Texas, 26 May 1928 (F. H. Benjamin) (in U.S. N.M.); 2 ♂♂, Corpus Christi, Texas, 15 & 28 Apr., 1943 (W. M. Gordon) (in B.M.); 2 ♂♂, same locality and collector, 4 June & 25 Sept.—15 Oct., 1943 (in C.U. & A.M.N.H.); 2 ♀♀, same locality and collector, 8 & 14 May 1943 (in C.U. & A.M.N.H.); 2 ♂♂, Corpus Christi State Park, near Mathis, San Patricio Co., Texas, 16 & 17 June 1969 (R. Heitzman).

GEOGRAPHIC DISTRIBUTION. See above.

Xubida dentilineatella (Barnes & McDunnough)

Fig. 11

Platytes dentilineatella Barnes & McDunnough, 1913, Contrib. Nat. Hist. Lepidoptera North America, **2:** 138–139, pl. 9, Figs. 16–17.

This species is readily distinguished by the general lack of distinct venous and intervenous lines, the dark shade running diagonally dorsobasad from the apex and the general yellowish brown color, most pronounced distally. It is a member, in fact, of a group of species, much alike in appearance and genitalia, which has many representatives in Mexico and Central America. The type species of *Xubida*, *dentilineella* Schaus, is a member of this group. *X. dentilineatella* appears to be quite rare.

TYPE MATERIAL. Type ♂, Palmerlee, Arizona, genitalia dissected, R. W. Hodges #3779 (in U.S.N.M.).

GEOGRAPHIC DISTRIBUTION. Southern Arizona; Mexico: Baja California.

Xubida puritella (Kearfott)

Fig. 12

Chilo puritellus Kearfott, 1908, Proc. U. S. Nat. Mus., **35:** 393.
Platytes dinephelalis Dyar, 1917, Insecutor Inscitiae Menstruus, **5:** 85.

This species shows considerable sexual dimorphism, males being much darker than females, often with pronounced dark shades on the forewings and dark gray hind wings, while females are very pale, almost white, and very lightly marked with dark scales along and between the veins. Kearfott named the one species from a female, Dyar the other from males.

TYPE MATERIAL. *puritella,* type ♀, Baboquivaria (sic) Mts., Pima Co., Arizona, July 15–30, 1902 (O. C. Poling), genitalia praep. R. W. Hodges #3785 (in U.S.N.M.); *dinephelalis,* type ♂, No. 21139, Baboquivera (sic) Mts., Pima Co., Arizona (through Dr. William Barnes) (in U.S.N.M.).

GEOGRAPHIC DISTRIBUTION. Baboquivari, Chiricahua, Huachuca and Santa Rita Mts., southern Arizona.

Xubida chiloidella (Barnes & McDunnough)

Fig. 13

Crambus chiloidellus Barnes & McDunnough, 1913, Contrib. Nat. Hist. Lepidoptera North America, vol. 2, no. 3, p. 138, pl. 8, fig. 10.

This species was named as a *Crambus* because of the idea that the stalking of vein R_2 on R_{3+4} was an important and unvarying generic character, which it is not. In all other ways *X. chiloidella* is a perfectly normal member of the Chiloini and of the genus *Xubida.* The strongly bifid costal process of the valva and the relatively large size and clear-cut dark markings are distinctive.

TYPE MATERIAL. Type ♂, White Mts., Arizona (Lusk) (in U.S.N.M.).

DISTRIBUTION. Southern and central Arizona.

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Habitat Preferences of some Species of a Müllerian-mimicry Complex in Northern Venezuela, and their Effects on Evolution of Mimic-wing Pattern

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Abstract: A large mimicry complex occurring in the montane cloud forest of northern Venezuela was observed during the summer of 1967. Distinct preferences were shown by many of the species for specific microhabitats and light intensities. The dominant family in the complex was the Ithomiidae, and over 90% of the individuals in the complex were Müllerian mimics. Some species of the complex were shown to belong to more than one mimicry complex, with the pattern of the complex centered around the Ithomiidae and the behavior of other complexes.

It is concluded that the mimicry complex is much larger than usually thought and that members of a mimicry complex do not have to resemble each other perfectly. Habitat differences and the selective advantage of cryptic coloration favor the evolution of a generalized pattern. It is hypothesized that a predator would find it easier to learn a single generalized pattern than several specific ones.

During the summer of 1967, the author spent three months at the Rancho Grande experimental station in the montane cloud forest north of Maracay, Venezuela, observing the members of a large mimicry complex occurring there. Of particular interest were distinct preferences shown by many of the species for specific microhabitats and light intensities. It is my purpose to describe these habitat preferences and then discuss their possible significance in the evolution of the mimetic pattern and the extent of the mimicry complex.

METHODS

Most of the conclusions drawn are from field observations during 700 hours of field time from June to September of 1967. The best observations were made in a forest path while sitting in a chair. Most species of mimics, especially species of the dominant butterfly family Ithomiidae, were not distracted by my presence. Some of the moths listed were not observed in the field but were collected at mercury vapor light after dark. Some of the rarer Ithomiidae and Pericopidae

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Acknowledgments: I wish to thank Dr. Francisco Fernandez-Yepez and the Universidad Central de Venezuela at Maracay for making the facilities of Rancho Grande available to me during the summer of 1967. Dr. George Eickwort of Cornell University read and helped correct an early draft of this paper. The research was done while I was a graduate student under Dr. John G. Franclemont in the Department of Entomology at Cornell University, and part of the expenses of my summer in Venezuela were paid for by the department.

New York Entomological Society, LXXVIII: 121–129. June, 1970.

were seen in the observation area only at Heliotrope plants used as bait. The use of *Heliotropum indicum* as an attractant for Ithomiidae, Pericopidae, Syntomidae, and Danaidae, has been described by Beebe (1955). No behavioral observations were made near the plants. Observations were confined to an area of about one-half kilometer in diameter. A description of the habitat at Rancho Grande has been given by Beebe and Crane (1947).

SPECIES COMPOSITION

The species I considered to belong to the mimicry complex are listed below and the majority figured in plates 1 and 2. The unorthodox combination of many different "types" is justified in the section discussing the evolution of the mimic wing pattern.

Both Batesian and Müllerian mimics are included in this complex, although it is not possible to state which are Batesian without testing them against possible predators. Species of the families Ithomiidae, Heliconiidae, Pericopidae, and Syntomidae are known to be distasteful to birds (Brower and Brower, 1964; Blest, 1964). Species of the family Ithomiidae made up over 85% of the total number of individuals and the Pericopidae about 5%. Of the total number of mimics, at least 90% were found to be Müllerian. Members of the mimicry complex formed the bulk of all diurnal Lepidoptera present, and only species of the butterfly family Satyridae were moderately common. The abundances and species diversity of the family Ithomiidae are being treated in another paper (Poole, m.s.).

HABITATS

A characteristic of tropical forest is the stratification of the trees (Richards, 1964). The herb layer at Rancho Grande is also structured into partially recognizable levels. For convenience, the herb layer was divided into three levels. Level one was defined as the plants occupying the area from the ground to about one foot. Level two was from one foot to two feet, and level three from two feet to six feet. Although each level was usually composed of characteristic species of plants, often smaller plants of levels three and two would be found in level one and so forth. Along the paths the average height of the ground cover decreased from the edge of the forest to the path. In open areas of the forest level three would be dominant and the other two levels almost absent. However, when the canopy was thick, all three levels were present but poorly developed.

I have attempted below to give a picture of the microhabitat preferences of the more common species of the mimicry complex (mostly ithomiids) occurring at Rancho Grande. Only species observed at least 25 times are included. The most common species were observed at least 100 times.

Along the paths through the forest, and sometimes in the forest proper, level one of the vegetation was occupied by *Oleria makrena* and *Oleria phemonoe*, *O. phemonoe* flying in lighter and slightly more open areas than *O. makrena*. The pericopid *Hyalurga leucophaea* also flew in level one but only on very cloudy, dark days or in thick vegetation. The second level was occupied by *Pteronymia nubivaga* and *Pteronymia veia*, although *P. nubivaga* was usually restricted to the lower part of the second level. *P. veia* was the most variable ithomiid in terms of microhabitat preference. In the third level were *Oleria victorine*, *Hymenitis andromica*, *Pteronymia beebei*, and *Hymenitis dercetis*. *Hymenitis dercetis* occurred in darker wetter forest than the other three species and was much more common higher in the mountains. Of the three other species, *Pteronymia beebei* flew usually along open paths, but *Oleria victorine* and *Hymenitis andromica* were often found in the forest.

Species cited arranged by families

ITHOMIIDAE

Xanthocleis aedesia Doubleday and Hewitson
Mechanitis isthmia Bates
Hyalyris cana Haensch
Hypothyris euclea Godart
Ithomia agnosia Hewitson
Ithomia iphianassa Doubleday and Hewitson
Oleria victorine Hewitson
Oleria makrena Hewitson
Oleria phemonoe Doubleday and Hewitson
Dircenna jemina Geyer
Ceratinia tutia Hewitson
Pteronymia adina Hewitson
Pteronymia asopo Felder
Pteronymia beebei Fox and Fox
Pteronymia veia Hewitson
Pteronymia nubivaga Fox and Fox
Godyris kedema Hewitson
Hymenitis andromica Hewitson
Hymenitis dercetis Doubleday and Hewitson
Episcada sp.
Pseudoscada timna Hewitson

HELICONIIDAE

Heliconius clysonymus Latrielle

PIERIDAE

Dismorphia medora Doubleday
Dismorphia critomedia Hubner
Dismorphia theucharila Doubleday
Dismorphia nemesis Latrielle

PERICOPIDAE

Thyrgis militta Stoll
Eucyane excellens Walker
Eucyane diana Butler
Eucyane hystaspes Butler
Eucyane temperata Walker (?)
Pericopis marginalis Walker
Pericopis angulosa Walker
Pericopis hypoxantha Hubner
Phaloe cruenta Hubner
Hyalurga leucophaea Walker
Hyalurga fenestra Linnaeus
Hyalurga urioides Schaus
Crocomela intensa Walker

SYNTOMIDAE

Aclytia keber Cramer
Euagra cerymica Druce
Correbia fana Druce

DIOPTIDAE

Josia flavissima Walker (?)

GEOMETRIDAE

Heterusia sp.
Crocypus sp.

PYRALIDAE

Phostria seminitidalis Schaus
Sylepta dioptalis Walker
Sylepta reginalis Cramer
Diaphania confinis Druce
Diaphania sp.
Pilocrocis dioptoides Walker
Pilocrocis leucoplagalis Hampson

In open areas of the forest two species occurred, *Ithomia iphianassa* and *Godyris kedema*, with *I. iphianassa* flying in the lower part of the vegetation and *G. kedema* at higher levels. In very open areas, *Mechanitis isthmia* was common, but it rarely occurred in the forest or open areas in the forest. *Hypothyris euclea* also seemed to prefer open areas as a rule but was seen several times in thick forest. Of the three species of *Dismorphia* (Pieridae) seen in the sample area, *D. critomedia* flew in level three of the forest, *D. medora* flew in level two and the upper part of level one, and *D. theucharila* flew close to the ground and most often down the center of paths.

This ordination of the ithomiids into different levels and places in the forest is not absolute, but a set of probabilities, i.e. a particular species of ithomiid was more likely to be found in one place than in another. This variability made it impossible to quantify my observations. Habitat fidelity depended on the species and was a characteristic of each, with some species more restricted in microhabitat choice than others. The differentiation between forest and open areas in the forest was particularly vague. The stratification of the ground cover was important to the ithomiids, probably because of its correlation with light intensity. As the light intensity changed, the species moved up and down

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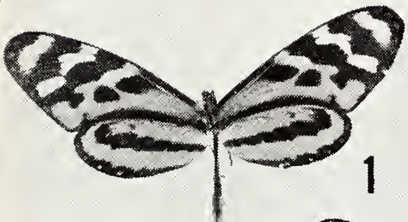
FIGS. 1–48. Members of the mimicry complex at Rancho Grande, Venezuela.

FIG. 1. *Mechanitis isthmia.*
FIG. 2. *Hypothyris euclea.*
FIG. 3. *Ithomia iphianassa.*
FIG. 4. *Hyalyris cana.*
FIG. 5. *Xanthocleis aedesia.*
FIG. 6. *Godyris kedema.*
FIG. 7. *Pteronymia veia.*
FIG. 8. *Hymenitis andromica.*
FIG. 9. *Hymenitis dercetis.*
FIG. 10 *Pteronymia asopo.*
FIG. 11. *Pseudoscada timna.*
FIG. 12. *Ithomia agnosia.*
FIG. 13. *Dircenna jemina.*
FIG. 14. *Heliconius clysonymus.*
FIG. 15. *Episcada* sp.
FIG. 16. *Pteronymia nubivaga.*
FIG. 17. *Pteronymia beebei.*
FIG. 18. *Oleria victorine.*
FIG. 19. *Oleria phemonoe.*
FIG. 20. *Oleria makrena.*
FIG. 21. *Dismorphia critomedia.*
FIG. 22. *Dismorphia nemesis.*
FIG. 23. *Dismorphia medora.*
FIG. 24. *Dismorphia theucharila.*
FIG. 25. *Pericopis angulosa.*
FIG. 26. *Pericopis hypoxantha.*
FIG. 27. *Pericopis marginalis.*
FIG. 28. *Hyalurga fenestra.*
FIG. 29. *Hyalurga urioides.*
FIG. 30. *Phaloe cruenta.*
FIG. 31. *Eucyane excellens.*
FIG. 32. *Eucyane temperata.*
FIG. 33. *Eucyane hystaspes.*
FIG. 34. *Eucyane diana.*
FIG. 35. *Thyrgis militta.*
FIG. 36. *Euagra cerymica.*
FIG. 37. *Phostria seminitidalis.*
FIG. 38. *Diaphania confinis.*
FIG. 39. *Crocypus* sp.
FIG. 40. *Pilocrocis dioptoides.*
FIG. 41. *Pilocrocis leucoplagalis.*
FIG. 42. *Sylepta dioptalis.*
FIG. 43. *Diaphania* sp.
FIG. 44. *Sylepta reginalis.*
FIG. 45. *Aclytia keber.*
FIG. 46. *Correbia fana.*
FIG. 47. *Josia flavissima.*
FIG. 48. *Hyalurga leucophaea.*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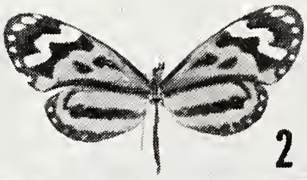
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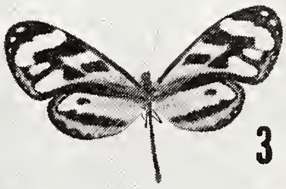
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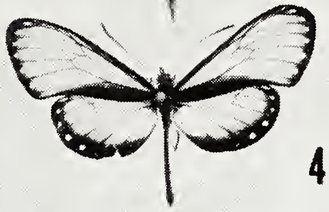
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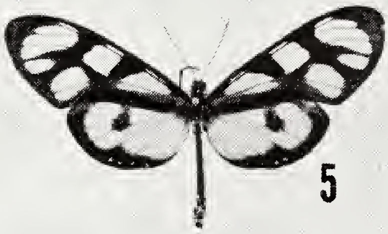
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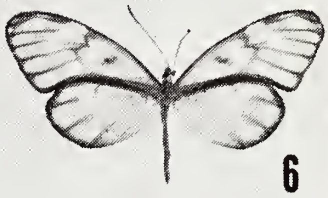
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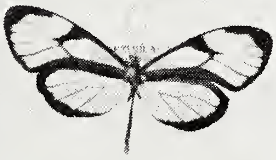
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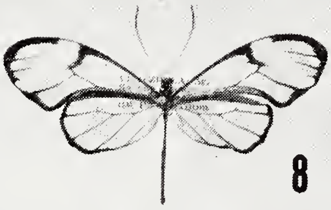
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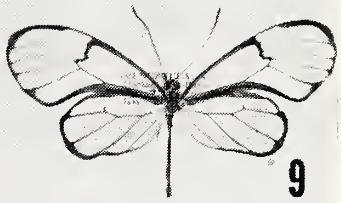
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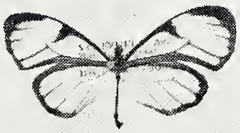
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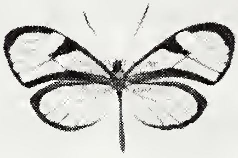
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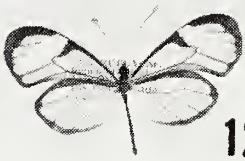
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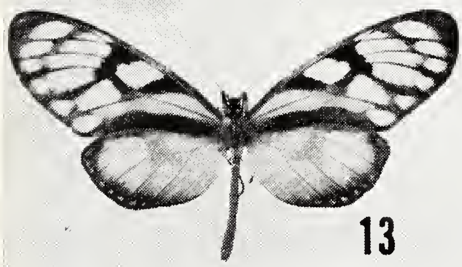
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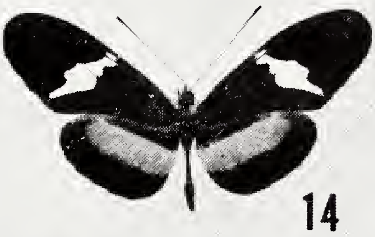
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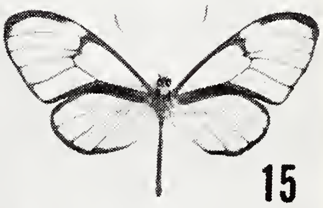
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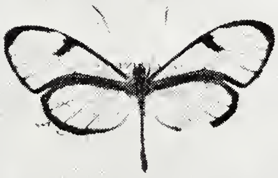
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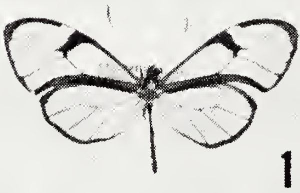
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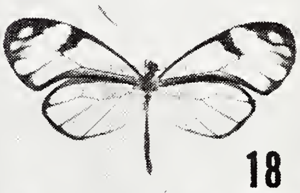
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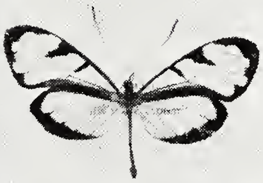
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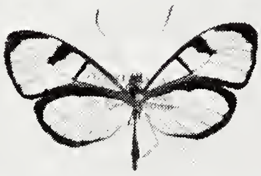
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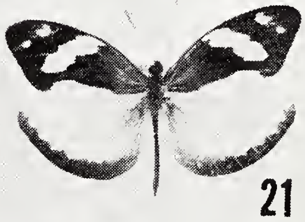
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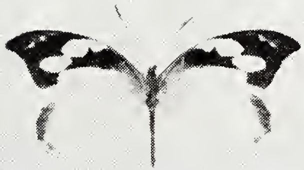
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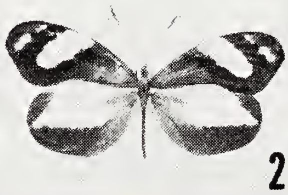
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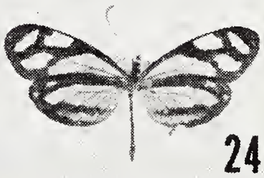
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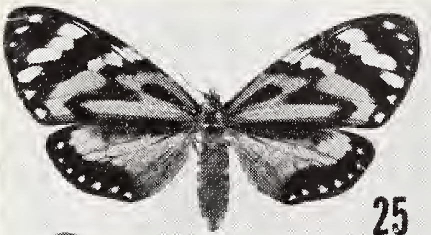
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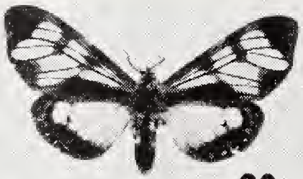
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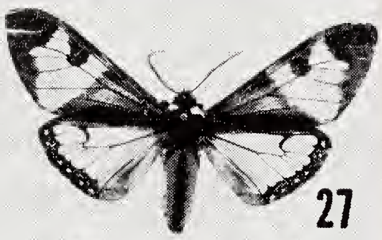
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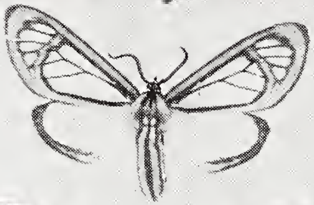
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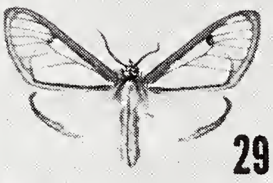
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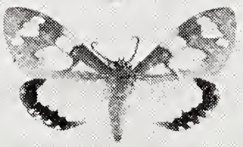
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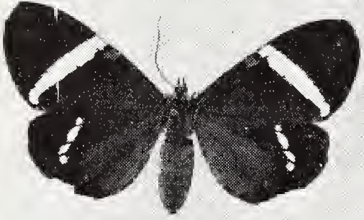
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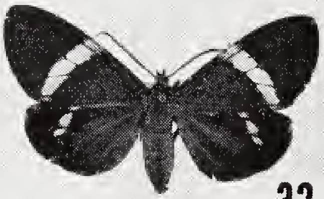
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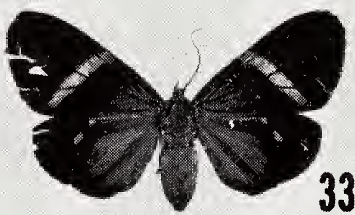
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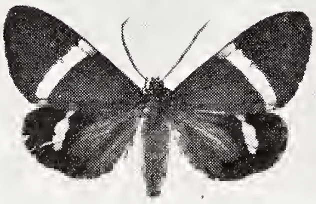
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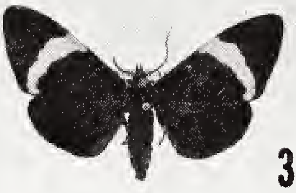
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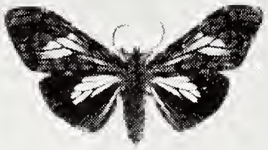
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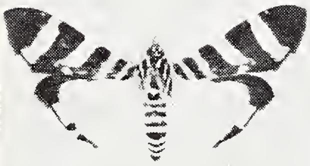
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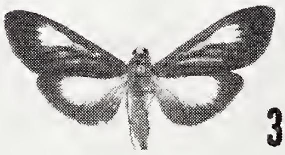
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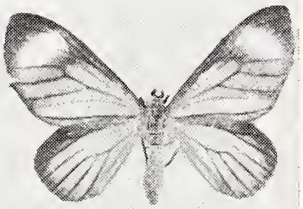
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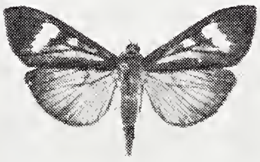
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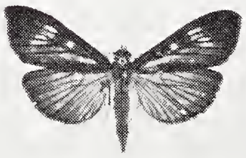
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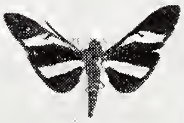
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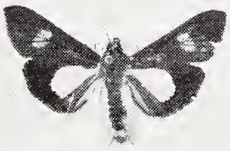
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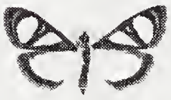
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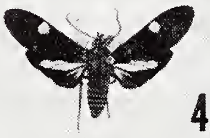
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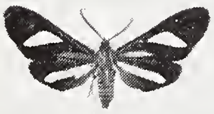
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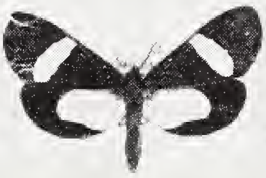
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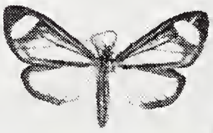
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in the cover. The apparent determining factor was light intensity and not an attraction to the level or place in which the species is normally found. One result of this response to light intensity was that many species of Ithomiidae flew at a lower level along a path than they did when flying in the forest. The Satyridae at Rancho Grande also exhibited this inclination to move up and down depending on light intensity. The tendency of the Ithomiidae to fly at different levels in the forest has also been noted by Brown and Mielke (1967) in Brazil.

DISCUSSION

In my opinion all of the species listed are members of one mimicry complex. Each different wing pattern is usually thought to represent a separate complex, but because of the significant selective advantage of an increased density of mimics (Holling, 1965) and the existence of an interspecific pheremone used to keep the various Müllerian members of the complex aggregated (Poole, m.s.), the existence of many separate Müllerian complexes is improbable. Schmidt (1958) working with chicks as predators and their reaction to artificial models and mimics found that a very incomplete resemblance between model and mimic caused avoidance. Many birds respond to generalized shapes or colors (releasers) rather than to details or specific patterns in instinctive behavior (Welty, 1962). In experiments with rats, Lashley (1938) found that many patterns were equivalent to the rats, even some dissimilar ones and states, "the animal reacts to a limited part of the total visual field and disregards variations in the remainder." Holling (1965) has shown mathematically that even small resemblances of pattern between model and mimic or two models will have a selective advantage.

Some elements of the wing patterns appear to be constant throughout the complex. These can be compared between the species in plates 1 and 2. In the forewing the pattern consists of a light patch set next to a dark one. The hindwing pattern consists of a dark border around a light center. The light area in the hindwing is achieved in several ways. In some ithomiids, for example *Oleria makrena*, the area is transparent; in others, such as *Mechanitis isthmia*, orange. In the pericopid genus *Eucyane*, the light area consists of metallic blue scaling. In many of the ithomiids, the central vein of the hindwing is conspicuous because of the transparency of the wing. In those species with orange hindwings, this vein is usually marked with black and well set off.

When ithomiids rest, the wings are folded over the back, and the lower surface of the wing is the pattern that serves as the signal to any insect predator. The optimal way of displaying a pattern at rest will probably be different than when moving since the lower wing pattern is different in some respects from the upper. The lower pattern consists of a row of white dots in a reddish to brown margin around the wings. The white dots are obscure in some members of this group, particularly those that fly under the lowest light conditions. At Rancho Grande the pericopids *Hyalurga leucophaea* and *Pericopis* spp. sit with the wings held flat against the leaf and, when sitting, it is the upper surface rather than the lower surface that shows. In these moths the upper surface has the pattern of the lower surface of the ithomiids, with the upper wing pattern of the ithomiids superimposed.

Some species belong to more than one Müllerian complex. The genus *Eucyane* and the three species of Syntomidae have the generalized pattern of this complex but also the metallic blue and behavioral patterns of another complex based on the wasp subfamily Pepsinae. The pericopid, *Pericopis marginalis*, has the pattern of the ithomiid complex, but the behavioral actions of a complex of arctiids, syntomids, saturnids, and noctuids that, when disturbed, lift the wings to display contrasting bands on the tergites of the curled-up abdomen. This display, studied by Blest (1964), probably represents a Müllerian complex based on a behavioral mechanism.

The pattern of each species will represent a compromise between convergence to a common "complex mimicry pattern" and adaptation to the habitat in which the species occurs. Light intensity and vegetation structuring are different from microhabitat to microhabitat, and in each microhabitat there will be an optimal wing pattern and way of presenting it. If two species occur in the same microhabitat, a perfect resemblance can be selected for. However, if the two species occur in different microhabitats, the resemblance, beyond a generalized pattern, will be a compromise between selection for better mimicry and selection for cryptic coloration. Aposematic coloration was not noticeable or did not occur in this complex at Rancho Grande. Most species of ithomiids were difficult to observe, particularly on cloudy or foggy days (cloud forest is foggy a large part of the time). If specific components of the pattern are not important to the predators, selection for cryptic coloration will probably be the stronger of the two pressures. In the ithomiids I noticed that those species occurring in the same general microhabitat tended to resemble each other most. For example, yellow, orange, and black species usually occurred in open areas, but the black, transparent species occurred in the forest. In the transparent species, those with yellow or white bands flew at higher levels in the vegetation than those with little or no yellow or white.

The generalized pattern has many advantages. It enables the species of the complex to adapt to its microhabitat and become cryptic as well as mimetic. A predator would probably find it easier to learn a generalized pattern than a complicated one. It would definitely be easier to learn one generalized pattern than several specific ones.

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W. V. Krivda (P.O. Box 864, The Pas, Manitoba, Canada) wishes to obtain for his research specimens of *Limenitis* or *Basilarchia* from the contact zone of *L. arthemis* and *L. a. astyanax.* He especially hopes for the "hybrids" between the two. The condition of the specimens is not important.

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Part I: The Systematics of *Anthocharis midea* Hübner (Lepidoptera: Pieridae)
C. F. dos Passos and A. B. Klots

Part II: A Revision of the Genus *Leptoglossus* Guerin (Hemiptera: Coreidae)
R. C. Allen

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ERRATA

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Oeneis alberta in New Mexico, a new subspecies (Lepidoptera: Satyridae)

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FOUNTAIN VALLEY SCHOOL
COLORADO SPRINGS, COLO. 80911

RECEIVED FOR PUBLICATION JANUARY 6, 1970

Abstract: A new subspecies, *Oeneis alberta* **capulinensis**, has been found in the grassy patches at the crater rim of Capulin Mountain, New Mexico. The butterfly is on the wing in mid-May and the flight is over in early June. This is essentially the same flight period as that of *O. a. oslari* Skinner, although the locality is about 1,000 feet lower and well over a hundred miles southeast of the nearest known *oslari* colony. The Capulin subspecies is quite variable but seems to approach *alberta alberta* closer than it does any other subspecies. The types and type series are deposited in the American Museum of Natural History.

While engaged in a general natural history survey of Capulin Mountain National Monument we started to accumulate a lepidoptera collection in the spring of 1968. This year the first collections were made on May 17 and 18, 1969. A few hibernators were seen. The very early *Erynnis*, probably *icelus*, and *Mitoura siva*, were flying around the oaks and junipers respectively. While making a circuit of the crater rim on May 17 a small, brown butterfly was flushed from a patch of grass on the outer north side of the rim. It proved to be an *Oeneis*.

Conditions were anything but favorable for collecting butterflies. The temperature was about 45°F; there was a 20-knot wind from the north; the slope was at critical angle, 37°; the grass-and-cinder footing was insecure and slippery. The next morning conditions were better. The wind was still out of the north but had dropped to about 5 knots. The temperature was in the low 70's. The slope and footing were unchanged. On both days collecting was done between 9:30 and 11:30 in the morning. The altitude ranged from 8,200 to 8,300 feet above sea level.

As is the case with *O. alberta oslari*, this strain of *alberta* rarely flies until it is kicked out of the grass clumps. On both days the insects went down wind, which was up hill on the cinder cone. Chase was out of the question. The flight was erratic, rapid and low, very often under 12 inches above the grass tops. Captures were made by stalking specimens seen to settle and trapping them under a net. Only males appeared to be flying. The one female taken was gravid and crawled along the ground among the grass clumps. Two others were seen but disappeared into the grass or into crevasses among the cinders.

The area occupied by the species is several acres in extent and is covered with bunch grass, *Festuca*(?). The leaf buds on the oaks were just beginning

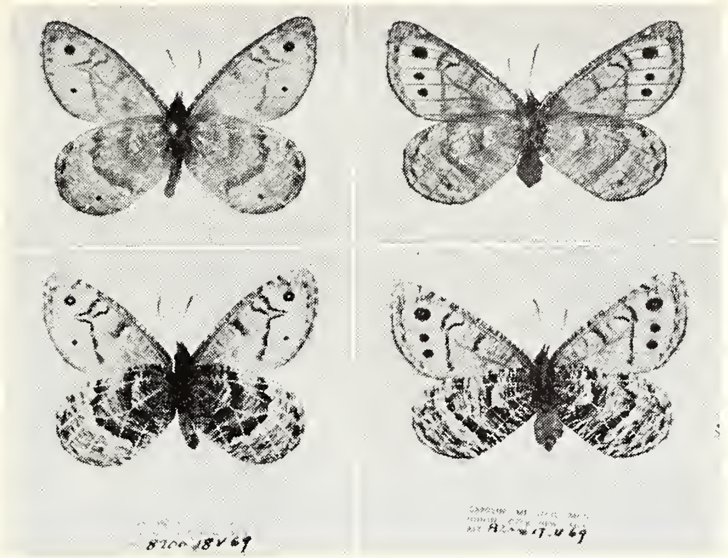

Fig. 1. Left, upper and lower sides of holotype male; Right, upper and lower sides of allotype female. Two-thirds natural size.

to swell. *Mertensia* was at the peak of its blooming and *Thermopsis*—a low-growing, erect, yellow-flowered "mountain pea"—was just coming into bloom. A similar situation exists on the inner side of the south rim of the crater. No butterflies were seen in that area although the bunch grass patch there is much larger.**

On May 30th a co-worker, Mr. James Mariner, visited the volcano for me and collected 16 additional specimens, six of them females. He found the butterflies at the same station I had worked and also a few yards higher on the cone. Unfortunately press of other work prevented either of us from exploring the high mesas some ten to fifteen miles to the north where it is quite possible other colonies of *alberta* will be found.

In 1953 I presented a detailed study of the variation found in *Oeneis alberta* and questioned the need for the subspecific name *oslari* Skinner. Dr. dos Passos, who has specialized in study of this difficult genus, differed with me and considers *oslari* a useful subspecific name. I bow to his superior knowledge.

The insect that flies on the slopes of Capulin crater differs from each of the three accepted subspecies of *alberta*. It is about the size of *oslari* Edwards, a

Table 1. Mean radius of the left forewing, in mm.*

	Males				Females			
Subspecies	*N.*	*rad.*	*S.D.*	*V.*	*N.*	*rad.*	*S.D.*	*V.*
daura	19	22.74	1.59	7.0	9	24.16	0.85	3.5
oslari	25	20.53	0.81	3.9	14	21.92	0.67	3.1
capulinensis	42	20.51	0.94	4.5	7	22.54	0.70	3.1
alberta	11	19.38	0.71	3.6	11	20.71	1.64	7.9

* Data for named subspecies from Brown (1953), Table 2.

** Captures were made on the south rim in May, 1970.

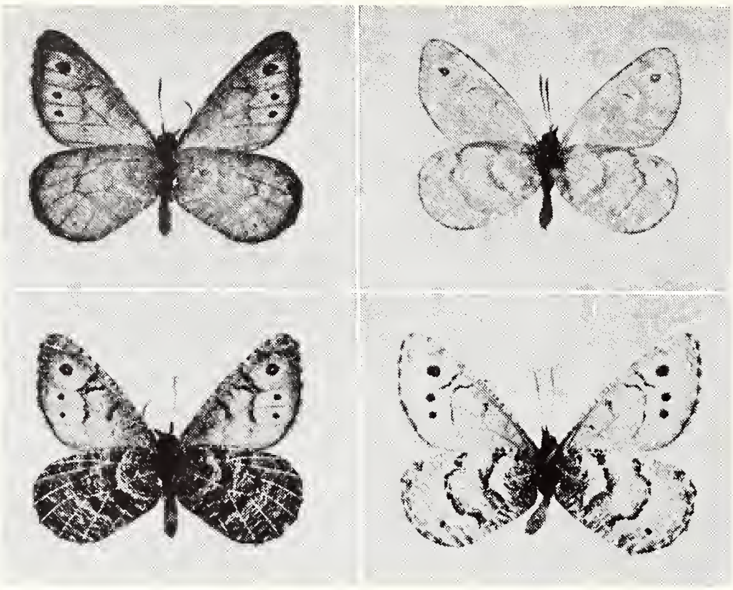

FIG. 2. Extremes in coloration of male *Oeneis alberta* **capulinensis**. Left, male paratype No. 17 upper and lower sides. This specimen suggests a miniature *chryxus*. Upper right, upper side male paratype No. 12. Lower right, lower side of male paratype No. 16. Two-thirds natural size.

little larger than *alberta* Elwes, and noticeably smaller than *daura* Strecker. The submarginal maculation on the upperside is more like that on *alberta* than on either *oslari* or *daura*, as can be seen from Table 2. The variations in the vadum and limbal band of the upper forewing of the males are like none of the named subspecies but on the females are like *alberta*. On the under side the situation is different. There the Capulin material is very like *alberta* in the development of the limbal line on the forewing and mesial band on the hind wing. These features are summarized in Table 3.

The variation observed in the short series studied suggests that the Capulin

TABLE 2. Frequency with which spots or ocelli occur on upperside.*

	Forewing			Hindwing		
Subspecies	M_1-M_2	M_3-Cu_1	Cu_1-Cu_2	M_3-Cu_1	Cu_1-Cu_2	Total
Males						
daura	1.000	.316	.798	.000	.798	.579
oslari	1.000	.240	.720	.040	.720	.544
capulinensis	1.000	.333	.524	.000	.596	.491
alberta	1.000	.273	.637	.000	.637	.509
Females						
daura	1.000	.778	1.000	.333	.889	.800
oslari	0.928	.572	.856	.000	.643	.600
capulinensis	1.000	.857	.857	.000	.572	.686
alberta	1.000	.728	1.000	.000	.637	.673

* Data for named subspecies from Brown (1953), Table 4.

Table 3. Frequencies for certain pattern features.*

Subspecies	Upperside forewing: Vadum present	Upperside forewing: limbal band present	Under side: fw limbal line absent	Under side: hw mesial band "absent"
Males				
daura	.798	.798	.673	.263
oslari	.640	.960	.360	.080
capulinensis	.905	.905	.000	.000
alberta	.546	.273	.091	.000
Females				
daura	1.000	.889	.111	.111
oslari	1.000	.856	.214	.000
capulinensis	1.000	1.000	.000	.000
alberta	.819	1.000	.000	.000

* Data for named subspecies from Brown (1953), Tables 5–8.

population is far more variable than any other studied population. The degree and kinds of variation suggest a limited population where isolation has allowed many recessive traits to appear phenotypically. Some of the specimens are quite like the average *daura* in color and patterning, others cannot be separated from *oslari* or *alberta*. One suggests a miniature member of the *chryxus* complex. There are some that suggest *uhleri*. It is possible that the Capulin Crater population represents the sort of *alberta* stock that took refuge in the southern plains during the Wisconsin glaciation.

The Capulin Crater population is not a relic stranded as the Wisconsin icesheet retreated. This colony cannot be more than 7,000 years old, the greatest age that has been assigned to the cinder cone as it stands. On geological grounds I am inclined to think that Capulin Crater became inactive more recently, possibly not more than 4,000 years ago. This poses an interesting question. What was the source of the pioneers? As yet the high mesas to the west, northwest and northeast of the mountain have not been explored for butterflies. Search of the grasslands on the Raton Mesa-Mesa de Mayo system in mid May should be done.

Oeneis alberta **capulinensis** n. ssp.

HOLOTYPE MALE. Radius of the left forewing is 21.1 mm. Upper side: Warm, light, greyish brown somewhat greyer at the base of the forewing. The pattern of the under side shows through faintly. On the forewing there is a white-pupiled ocellus in M_1-M_2 and a smaller blind one in Cu_1-Cu_2. The area immediately surrounding these ocelli and in small patches between the other pairs of veins the ground color is a little clearer, less grey. Close to the margin of the wing there are five inconspicuous dark points between the veins beginning in the apex and extending to M_3-Cu_1. For the same area the fringe is checkered.

On the hind wing there is a small dark point in Cu_1-Cu_2 and smaller light points anteriorly between the veins. The vadum is about 1½ mm. wide and alternately dark and light brown, The fringe is checkered. The mesial band is prominent, partly through translucence of the wing.

Under side: Generally much paler than the upper side. The forewing is lightly irrorate with darker lines in the cell and along the costa and in the apex. There is a bar across the cell and a dark line at its extremity. Beyond this the limbal line parallels the cell-end line and at M_3 makes a sharp "V" outward along that vein. From there to the anal vein the limbal line is rather straight. The ocelli are as above.

On the hind wing the irroration is uniform over the entire surface. The base of the wing, the margins of the mesial band and in the apex near the margin there is marked darkening. The veins are lined with pale cream scales and stand out clearly. The ocellus is as above.

DATA. Outer slope of north rim of the crater, Capulin Mountain, Union County, New Mexico, 8,200 feet above sea level, 18 May 1969, collected by F. M. Brown.

ALLOTYPE FEMALE. Radius of the left forewing is 22.2 mm. Upper side: Very much like that of the male but a little less grey and therefore brighter colored. The vadum and limbal band of the forewing are well defined and there are blind ocelli in M_1-M_2, M_3-Cu_1 and Cu_1-Cu_2. The hind wing is little different from that of the holotype male.

Under side: Essentially the same as on the holotype male except for the number of ocelli on the forewing. The limbal line does not form a "V" on M_3.

DATA. The same as for the holotype except collected on 17 May 1969.

PARATYPES. 41 males, thirteen of these collected on 17 May and eighteen on 18 May 1969, by F. M. Brown. James Mariner collected ten on 30 May. Six female paratypes were collected by Mariner on 30 May. The entire type series has been deposited in the American Museum of Natural History, New York, N. Y. This is done to preserve it intact as evidence of the great variation found among specimens of this subspecies of *alberta*.

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Scanning Electron Microscopy of *Solenopotes capillatus* Enderlein (Anoplura: Linognathidae)

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Received for Publication December 17, 1969

Abstract: The males and females of *Solenopotes capillatus* Enderlein were studied with the scanning electron microscope. It was found that the abdomenal integument was similar to the sclerotic, squamous texture described in *Linognathus vituli* and *L. taurotragus*, rather than the membranous appearance previously reported. The sternal region was found to have the same texture as the abdomen. Campaniform organs were found on the lower surface of each trochanter as had been reported for other Anoplura. A campaniform organ was also seen on the second antennal segment. The antennal sensorium on each of the last two segments were found to be sensilla coeloconica, the pegs of which terminate in an average of 11 projections from its apex. A small torus-shaped structure with a central projection was seen on the fifth or terminal segment; this has not been previously described.

The scanning electron microscope (S.E.M.) provides an opportunity to examine the surface of insects at magnifications and a depth of field greater than is possible with the light microscope. Another advantage of this microscope is the minimum preparation of specimens which is needed prior to studying them. Pease et al. (1966), Scheie et al. (1968), and Salkeld and Wilkes (1968) demonstrated topographical views of insect structures at low to high magnifications which enabled these to be studied in relationship to each other and to the insect as a whole. This should lead to more accurate descriptions, better taxonomic keys, and an increased understanding of insect physiology.

Although the Anoplura are of economic importance, little information concerning their morphology and physiology is found in the literature. A partial explanation may be that specimens are cleared in potassium hydroxide (KOH) or another clearing agent prior to identification. This process, although valuable for taxonomic purposes, damages external morphological structures. Thus, it is difficult to make detailed studies of fine structures and to determine the relationship of surface structures to each other and to the insect as a whole. Miller (1969) used the S.E.M. to demonstrate pore organs which may be associated with the sensilla basiconica on the antennae of *Pediculus humanus*

Acknowledgments: My sincere thanks to Doctors John L. Duffy and Irving Abrahams of Meadowbrook Hospital for their discussions and reading of the manuscript. I am grateful to Miss Elena Fortuna for typing the manuscript. A special thanks to those cited in this paper for supplying the specimens needed for this study.

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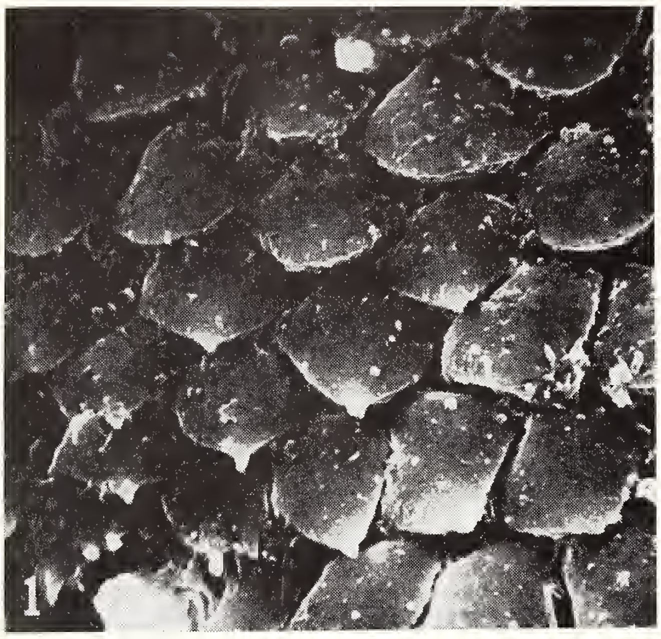
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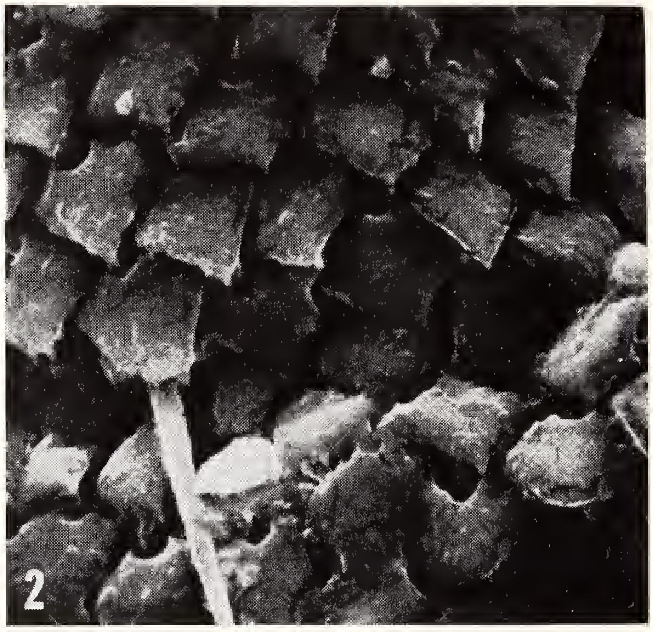
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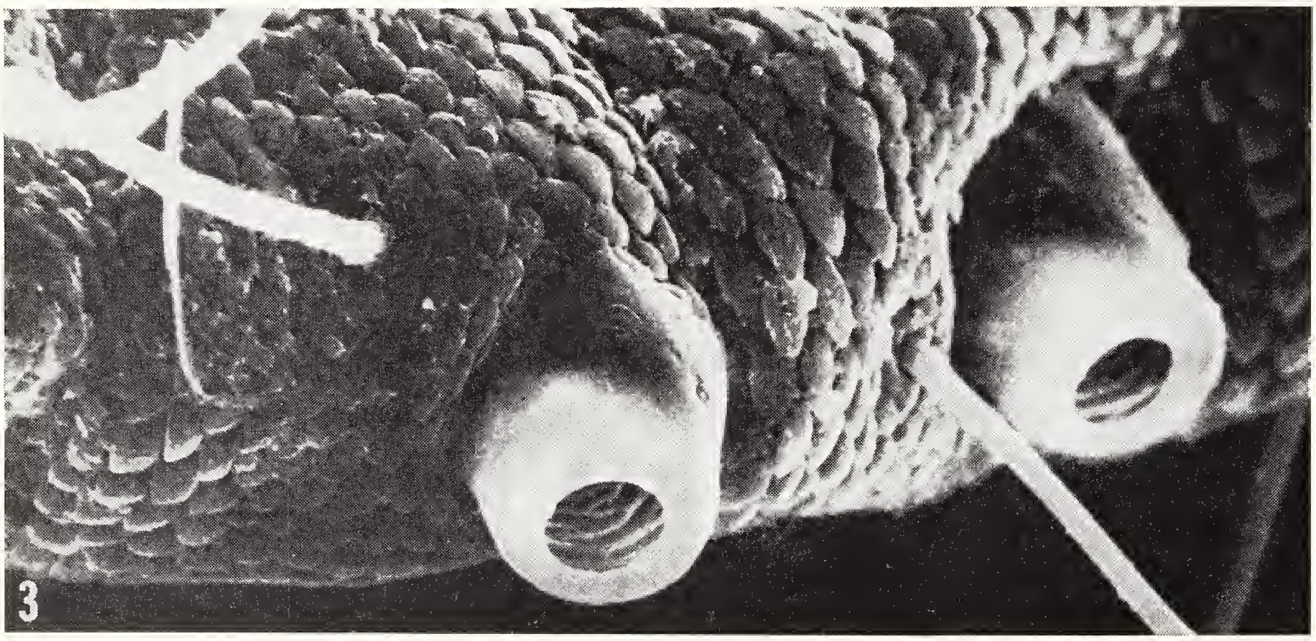
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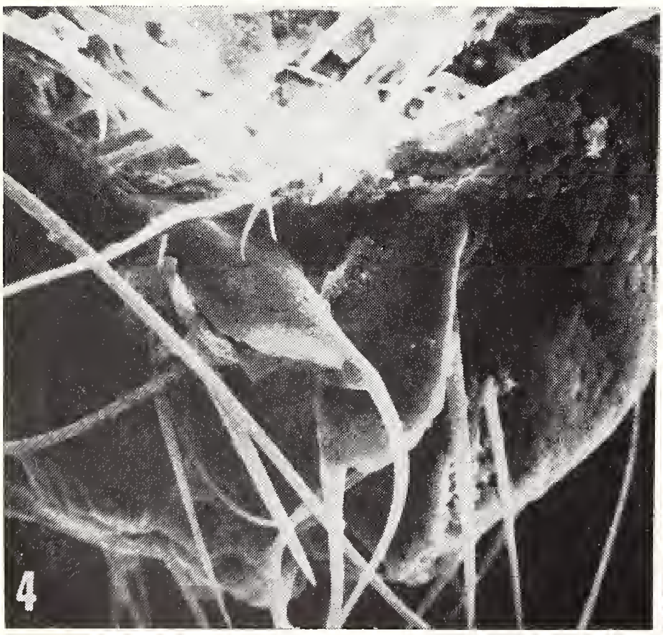
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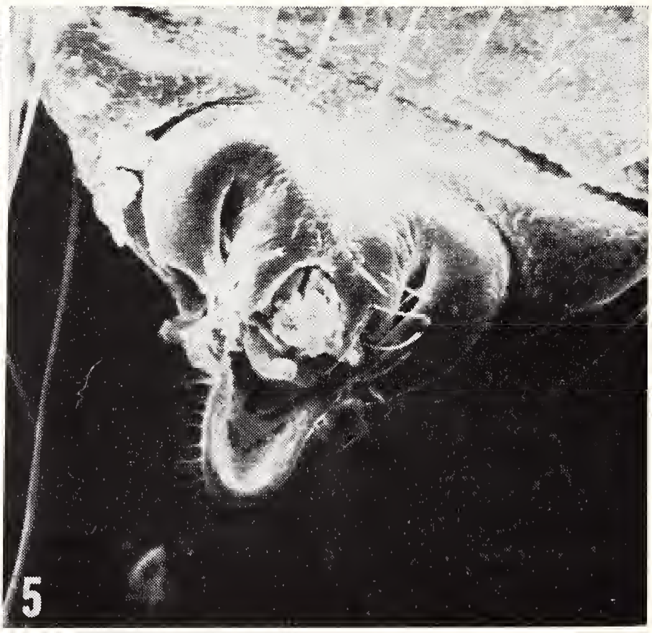
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L. and *Phthirus pubis* (L.). He, also, studied in detail (1970) some integumental modifications of the antennae of *Polyplax serrata* (Burmeister).

The present S.E.M. study of *Solenopotes capillatus* Enderlein describes several surface structures either previously not described, or whose descriptions have been vague, or misleading. A few other structures are also reported in greater detail than has been previously possible.

MATERIALS AND METHODS

Thirty-six specimens of *Solenopotes capillatus* Enderlein were studied. The specimens used in this report were furnished by Ke Chung Kim of Pennsylvania State University, D. S. Dunlap of Washington State University, and E. M. Nevill of the Department of Agricultural Technical Services, Republic of South Africa. Twelve specimens from each lot, 6 males and 6 females were studied. Six specimens of *Linognathus vituli* furnished by E. M. Nevill were also examined. The specimens were received in 70% alcohol. They were washed in several changes of fresh 70% ethyl alcohol prior to being mounted. The specimens were cemented to specimen stubs with aluminum paint and dried in air. They were then coated with approximately 200 Å of gold by means of vacuum evaporation and studied with a Cambridge Steroscan Mark II S.E.M. at 20kv.

RESULTS AND DISCUSSION

The general description of the adult male and female *Solenopotes capillatus* can be found in a paper by Bishopp (1921), and Ferris (1951) has provided a good illustration. The present discussion is limited to areas ambiguously described or not described at all in the previous literature.

Ferris (1951) describes the Family Linognathidae as having an entirely membranous abdomen in both sexes except for the plates associated with the terminal and genital segments. Four genera, *Linognathus*, *Microthoracius*, *Prolinognathus*, and *Solenopotes* are assigned to this family. The only indications of variations in the abdomenal integument, other than the number and size of setae, are in the genus *Microthoracius* where the "derm" as reported by Ferris is minutely wrinkled, and in drawings of *Linognathus vituli* (Linn.) and *Microthoracius cameli* (Linn.) which show "dermal reticulation."

Earlier, Ferris (1932) had described the integument of the abdomen of the

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EXPLANATION OF FIGURES

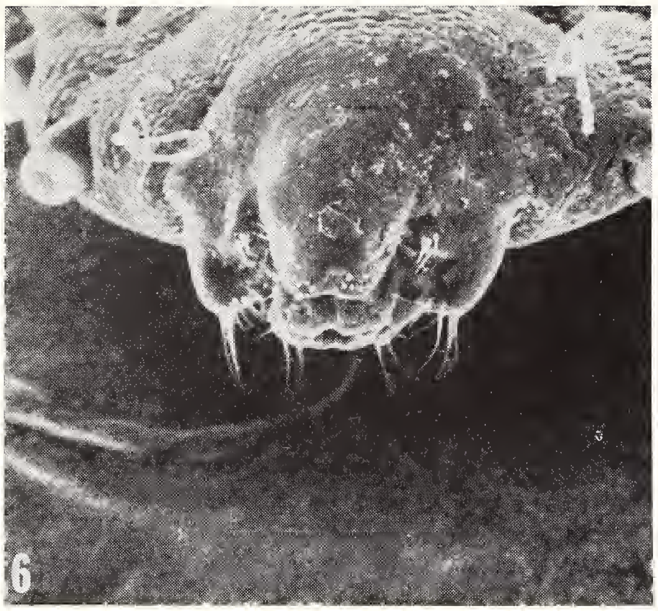
Fig. 1. Integument of *Solenopotes capillatus*. 1,000×.

Fig. 2. Integument of *Linognathus vituli*. 1,000×.

Fig. 3. Spiracles of abdomen of *Solenopotes capillatus*. 700×.

Fig. 4. Female genitalia of *S. capillatus*. 500×.

Fig. 5. Dorsal view male genital plate of *S. capillatus*. 200×.



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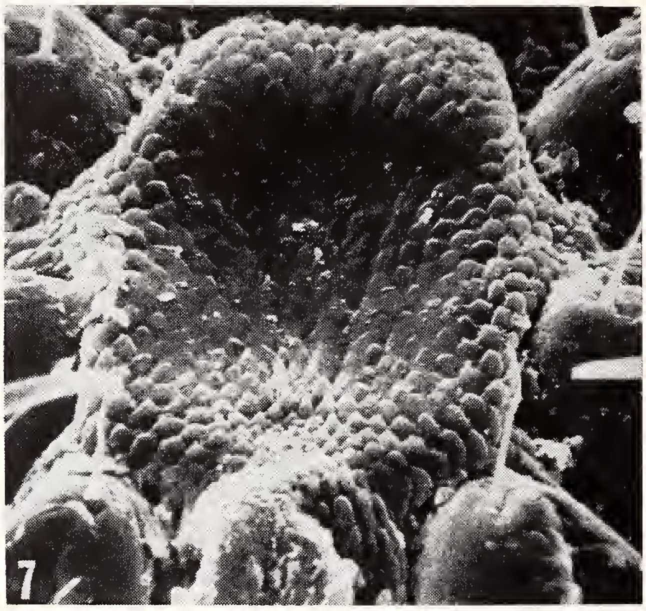

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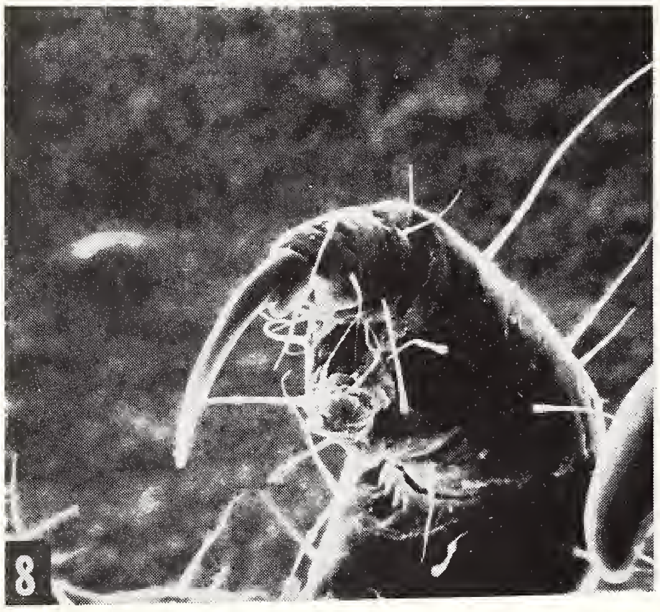

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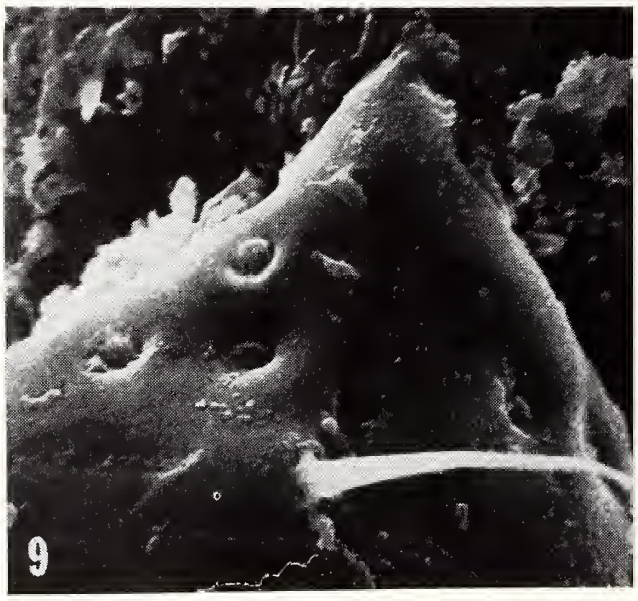

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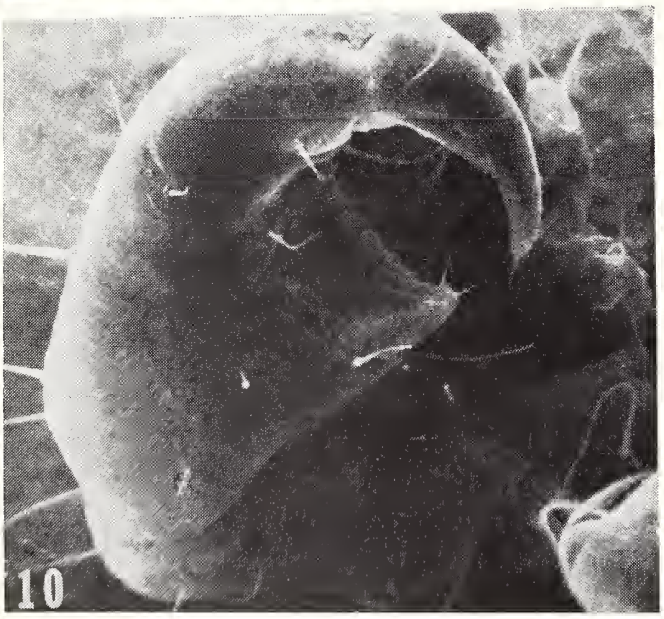

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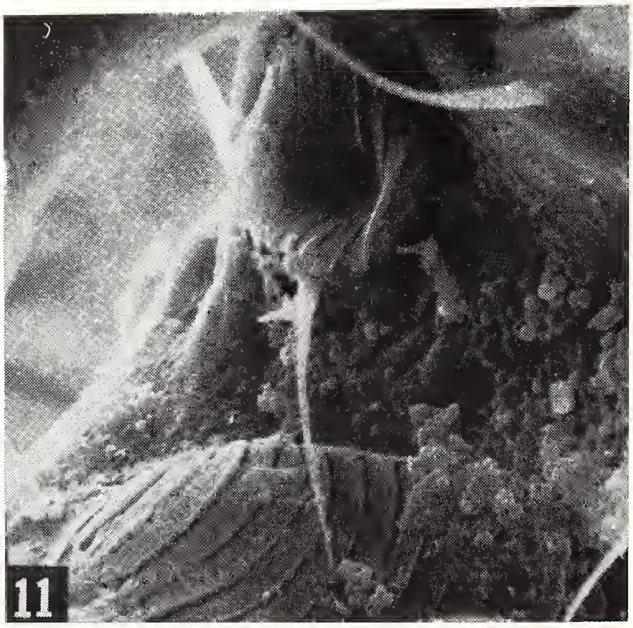

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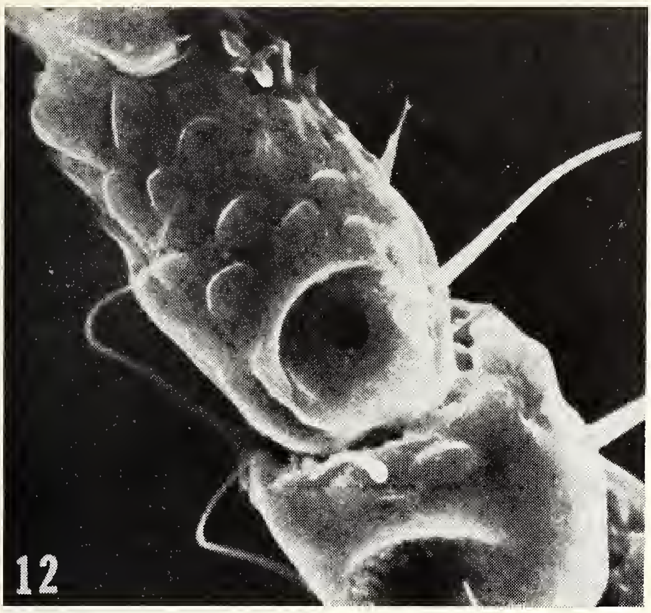

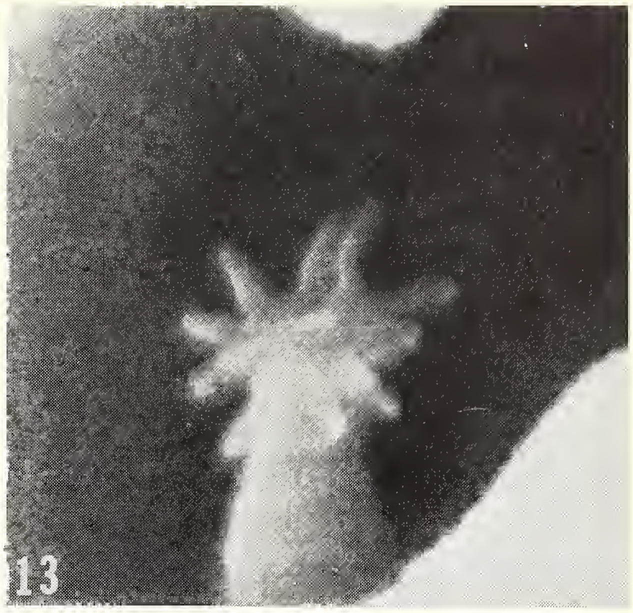

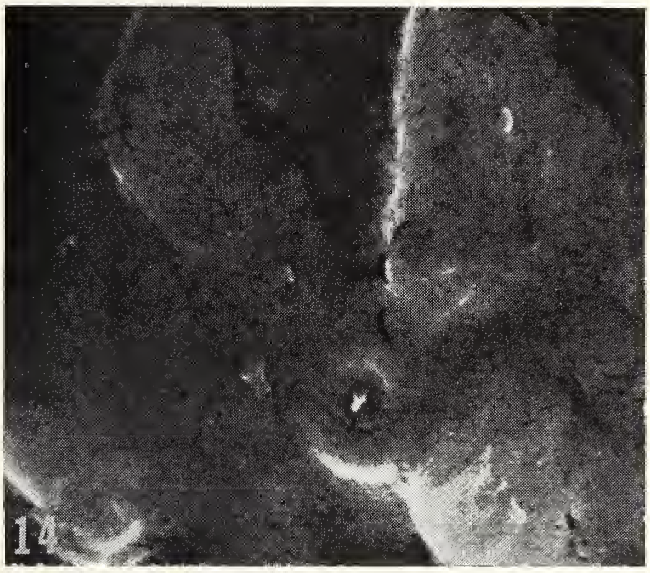

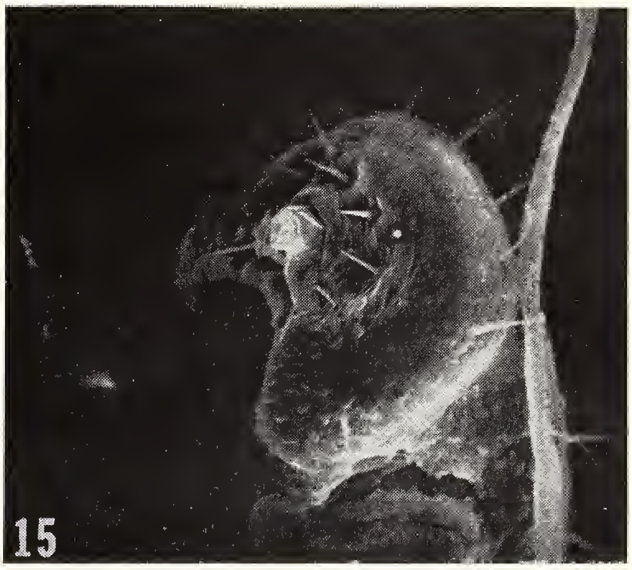

Fig. 12. Fourth and fifth antennal segments of *S. capillatus* showing *sensilla coeloconica* in segments. 1,000×.

Fig. 13. Peg of *sensilla coeloconica* from antenna of *S. capillatus.* 10,000×.

Fig. 14. Torus-shaped structure of fifth antennal segment of *S. capillatus.* 2,500×.

Fig. 15. Head of *S. capillatus.* 250×.

genus *Linognathus* as "membranous throughout and more or less squamate reticulate, sometimes sclerotic and pigmented." However, this is reported in only two species (*L. vituli* (Linn.) and *L. taurotragus* Bedford) of the twenty-three he reviewed. The integument of *Solenopotes capillatus* is reported as

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Fig. 6. Ventral view male genital plate of *S. capillatus.* 200×.

Fig. 7. Sternal region of *S. capillatus.* 700×.

Fig. 8. Front-leg showing slender claw of *S. capillatus.* 500×.

Fig. 9. Campaniform organs on trochanter of second leg of *S. capillatus.* 1,000×.

Fig. 10. Second leg of *S. capillatus* showing fusion of tibia and tarsus. 500×.

Fig. 11. Pads in tibial arch of second leg of *S. capillatus.* 1,000×.

membranous throughout except for the spiracular tubercles and tergite and genital areas. However, scanning electron microscopy reveals that the abdomen of *S. capillatus* has a squamous integument (Fig. 1). Studies of *Linognathus vituli* reveal a similar squamous integument (Fig. 2).

The spiracles with their strongly sclerotic, prominent tubercles projecting from the segments (Fig. 3) constitute the most distinctive character of the species. The genital region on the female (Fig. 4) and the genital plate of the male (Figs. 5 and 6) are similar to that described by Ferris (1932).

The dorsal view of the thorax is quite similar to that pictured by Ferris (1951). However, Ferris (1932) and Bishopp (1921) both describe a sternal plate that fills most of the space between the coxas as being somewhat hexagonal in shape; Bishopp says it is not very chitinized. The plate is not distinct on the specimens examined, but the texture of this area (Fig. 7) is similar to that of the abdomen. The descriptions of the legs by Ferris (1932) are here verified. The fore-legs have a slender claw (Fig. 8) and the middle and posterior legs have the tarsus and tibia closely fused and enlarged and terminating in a stout claw (Fig. 10). Striated pads are present on the distal end of the tibia, or the distal tibia arch of the middle and posterior legs (Fig. 11). Wigglesworth (1941) found campaniform organs on the lower surface of each trochanter on *Pediculus humanus*, these are present in this species (Fig. 9) as well as other specimens examined.

The five segmented antennae have what appears to be a campaniform organ on the second segment. The sensoria reported by Ferris (1932) on each of the last two segments are found to be sensilla coeloconica (Fig. 12). The pegs of these sensilla, which often cannot be seen from the surface, terminate in an average of 11 projections from their apex (Fig. 13). Toward the apex of the fifth or terminal antennal segment there is a small torus-shaped structure measuring 3.5 to 4.0 microns in diameter, with a central projection (Fig. 14) which does not resemble any structures previously described. The ventral aspect of the head appears less chitinized than that of its dorsal aspect (Fig. 15).

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Biological Observations on the Parasitic Bee *Kelita* (Hymenoptera: Apoidea)

Jerome G. Rozen, Jr.[1]

Received for Publication January 20, 1970

Abstract: The bee *Kelita chilensis* (Friese) is reported to be a nest parasite of *Psaenythia parvula* Friese (Panurginae). The following details of the biology of *K. chilensis* are described: the flight behavior of males and females, the egg, and the egg insertion in the cell wall of the host.

The genus *Kelita* Sandhouse (= *Herbstiella* Friese) (Anthophoridae, Nomadini) contains a single species, *K. chilensis* (Friese), which is known from only a few localities in central Chile. Because little has been recorded concerning its biology, the following brief observations are presented. I would like to thank Prof. Haroldo Toro, Universidad Católica, Valparaiso, for showing me the area at Peñuales, Valparaiso Province, Chile, where the observations were made.

At the first visit to the site on October 6, 1969 I saw a few individuals of *Kelita* patrolling along a dirt footpath which extended across the top of a hill. Because individuals of *Psaenythia parvula* Friese (Panurginae) were common and were of about the same size as the parasite, I suspected that *K. chilensis* attacked the nests of the panurgine. When I returned to the area on October 28, 1969, *K. chilensis* was more abundant than at the first visit. Males flew swiftly close to the ground, as did numerous males of *P. parvula*, and landed frequently in barren areas. Females of *K. chilensis* flew in a similar fashion to the males but their paths zigzagged more, especially at approaches to potential nest entrances of the host. The female's flight, much swifter than the slow deliberate flight of female *Nomada* (Nomadini), resembled the search flights of other small parasitic bees such as *Holcopasites* (Holcopasitini) and *Oreopasites* (Ammobatini) of North America, except that *Kelita* zigzagged more actively near possible nest openings.

An egg of *Kelita* was recovered from the only nest of *Psaenythia parvula* found. The shallow nest (cell depth 6 cm.) possessed a meandering open main burrow and a single open, empty, essentially horizontal cell, tipped slightly toward the rear. The egg was embedded in the upper part of the wall halfway toward the rear of the cell. With a smooth, shiny, thin, transparent chorion, the straight or gently curved egg was inserted at a slight angle (Fig. 1) into

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[1] Chairman and Curator, Department of Entomology, the American Museum of Natural History. Funds for the research came from National Science Foundation Grant GB-5407.

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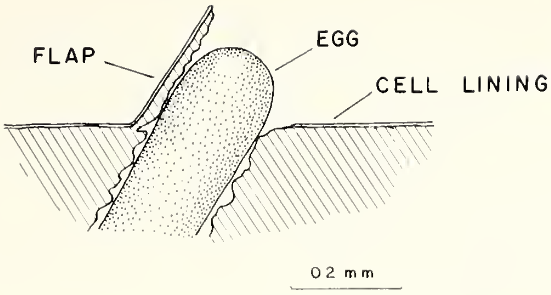

Fig. 1. Diagram of egg and egg insertion of *Kelita chilensis* (Friese) in cell wall of *Psaenythia parvula* Friese.

a hole provided with a flap consisting of the conspicuous cell lining and a thin layer of soil. The rounded, exposed end of the egg protruded about as much as the diameter of the egg. The egg and egg insertion appeared essentially the same as those of *Nomada* and *Holcopasites*; the end of the egg was not flattened like that of *Triepeolus* (Epeolini), nor was the chorion thick as is the case with *Neopasites* (Biastini).

Friese (1916), in the description of *K. chilensis*, stated that it may be a parasite of *Liphanthus sabulosus* Reed (= *Psaenythia rufiventris* Friese). The similarity in body size of parasite and suspected host also suggests the association, so that *K. chilensis* may have several hosts. However, near Tilama, Coquimbo Province, I found *L. sabulosus* in abundance, but none of the parasites.

The Chilean panurgine fauna consists of more than 20 described species and numerous undescribed ones. *K. chilensis* is the only parasitic bee associated with this fauna and, indeed, is the only small parasitic anthophorid known from Chile. In North America many panurgines are hosts of many species of small parasitic anthophorids belonging to a number of genera. Although Chilean bees are still poorly known, it is surprising that more small parasitic bees are not known from there.

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Podonominae from Ecuador, with Notes on the Sense Organs and Pupal Respiratory Organs (Diptera: Chironomidae)

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Received for Publication May 1, 1970

Abstract: Two new species of *Podonomus* from Ecuador are described—*Podonomus* **caranqui**, adult and pupa, and *Podonomus* **quito**, adult, pupa, and larva. The association of the pupa of these species with blackfly puparia is discussed. The cast pupal skin of the species of *Parochlus* from the same collection is described. The distribution and types of sensilla of the adult wings, legs and antennae and the pupal tergites are given. The structure of the pupal respiratory organs, especially the plastron, is described and comparison is made with the plastron of representative Tanypodinae species.

The species here described were collected by Dr. Pedro Wygodzinsky, in the pupal stage, from the Rio Sumbahua in Cotopaxi Province, Ecuador. The notes, graciously furnished me by Dr. Wygodzinsky, show that the pupae of both *Podonomus* species are associated with the pupal cases of the simuliid genera *Simulium* and *Gigantodax*. The *Podonomus* pupae are highly mobile and are able to "walk" on the rocks with the help of the spinous appendages of the abdomen. They take shelter close to and in the blackfly pupal cases. The collection made by Dr. Wygodzinsky contained several blackfly pupal cases filled by 4–5 pupae and shed larval skins of *Podonomus* **quito**,[2] figs. 49, 50. This shows that the larvae crawl into the blackfly pupal cases while still inhabited by the blackfly pupae or while the cocoon is empty and use them as a shelter in which to pupate. The larvae, as Brundin (1967) notes, with their strongly developed proleg claws are capable of withstanding the full strength of the torrential currents in which they live. The pupae are, however, obviously not so well endowed and must seek shelter to avoid being swept away before the adult is ready to emerge.

The adult male of *Podonomus* **caranqui**[2] and the adult females of both species of *Podonomus* had been reared by Dr. Wygodzinsky. The presence of mature pupae with well developed genitalia permitted the association of the

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[1] In addition to my great debt to Dr. Wygodzinsky, I am also indebted to Dr. Eleanor Slifer who gave extensively of her time and knowledge to help interpret the sensory structures and to Mr. Stanley Luszcz of the Franklin Institute Research Laboratories for the excellent scanning electron microscope photographs reproduced in figures 53–76.

[2] These names are based on two of the pre-Inca tribes of Ecuador.

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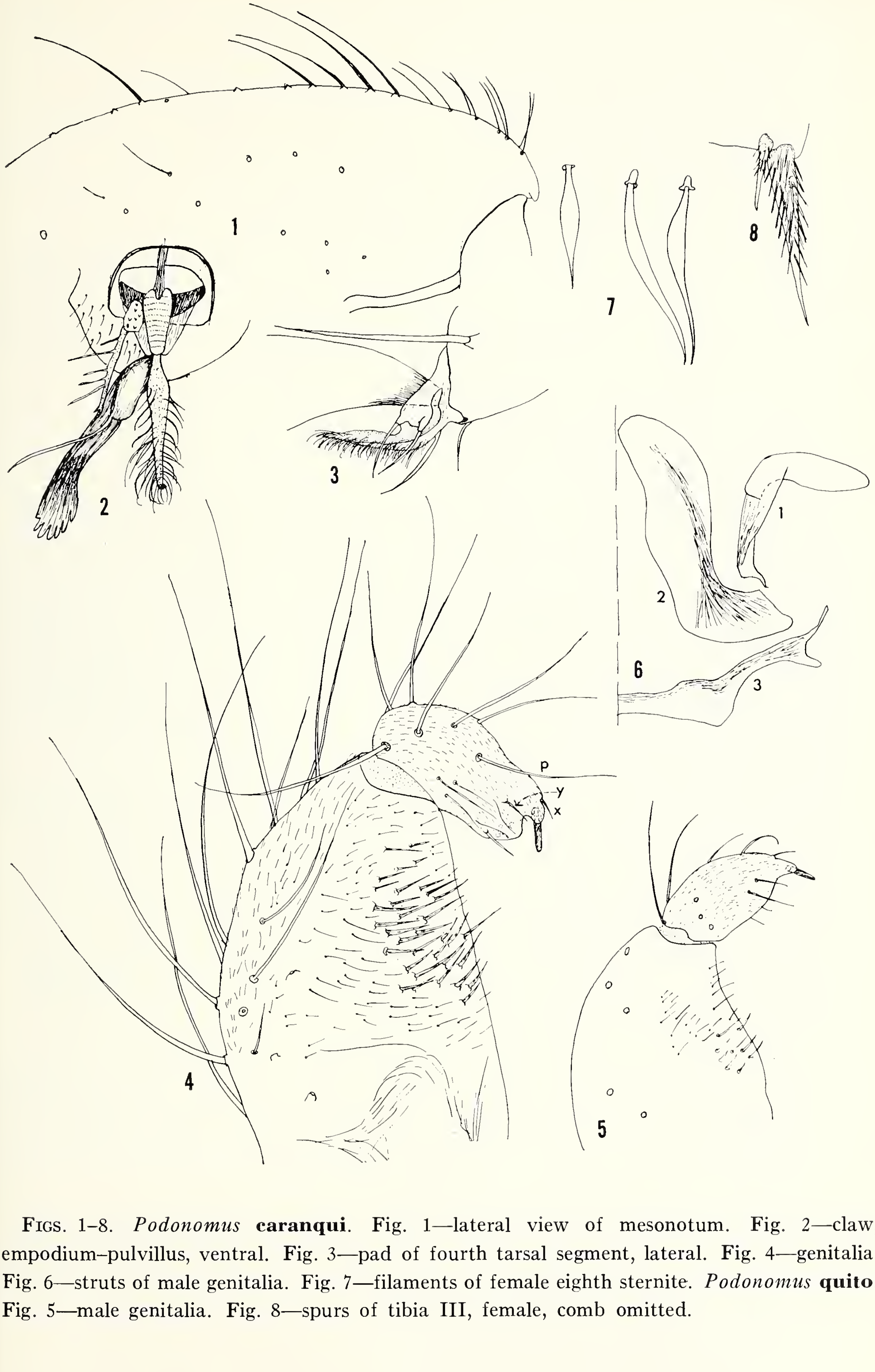


Figs. 1–8. *Podonomus* **caranqui**. Fig. 1—lateral view of mesonotum. Fig. 2—claw, empodium–pulvillus, ventral. Fig. 3—pad of fourth tarsal segment, lateral. Fig. 4—genitalia. Fig. 6—struts of male genitalia. Fig. 7—filaments of female eighth sternite. *Podonomus* **quito**. Fig. 5—male genitalia. Fig. 8—spurs of tibia III, female, comb omitted.

pupal and adult stages of both species. *Parochlus* nr. *maorii* Brundin was represented by only a single cast pupal skin.

Symbols and Ratios Used in Text and Figures

AR—Antennal ratio, considering pedicel as seg. 1: ♂ segments 14 & 15/2–13
♀ segment 10/2–9
ARC—Arculus to r-m/arculus to wing tip
BR—Length of basistyle/length of dististyle
Cx—Coxa
F—Femur
fR—Fork of radius
LR—T_1/Ti of each leg
RR—Height of cell R_1/height of cell R_{4+5}: taken from apex of R_1
R_1, R_{4+5}—Radial veins
S_c—Subcosta
T_{1-5}—Tarsal segments
Ti—Tibia
Tr—Trochanter
8S—Eighth sternite
9T—Ninth tergite
I–III—Pro-meso-and metathoracic legs.
(AMNH)—American Museum of Natural History
(ANSP)—Academy of Natural Sciences of Philadelphia

Podonomus **caranqui** new species

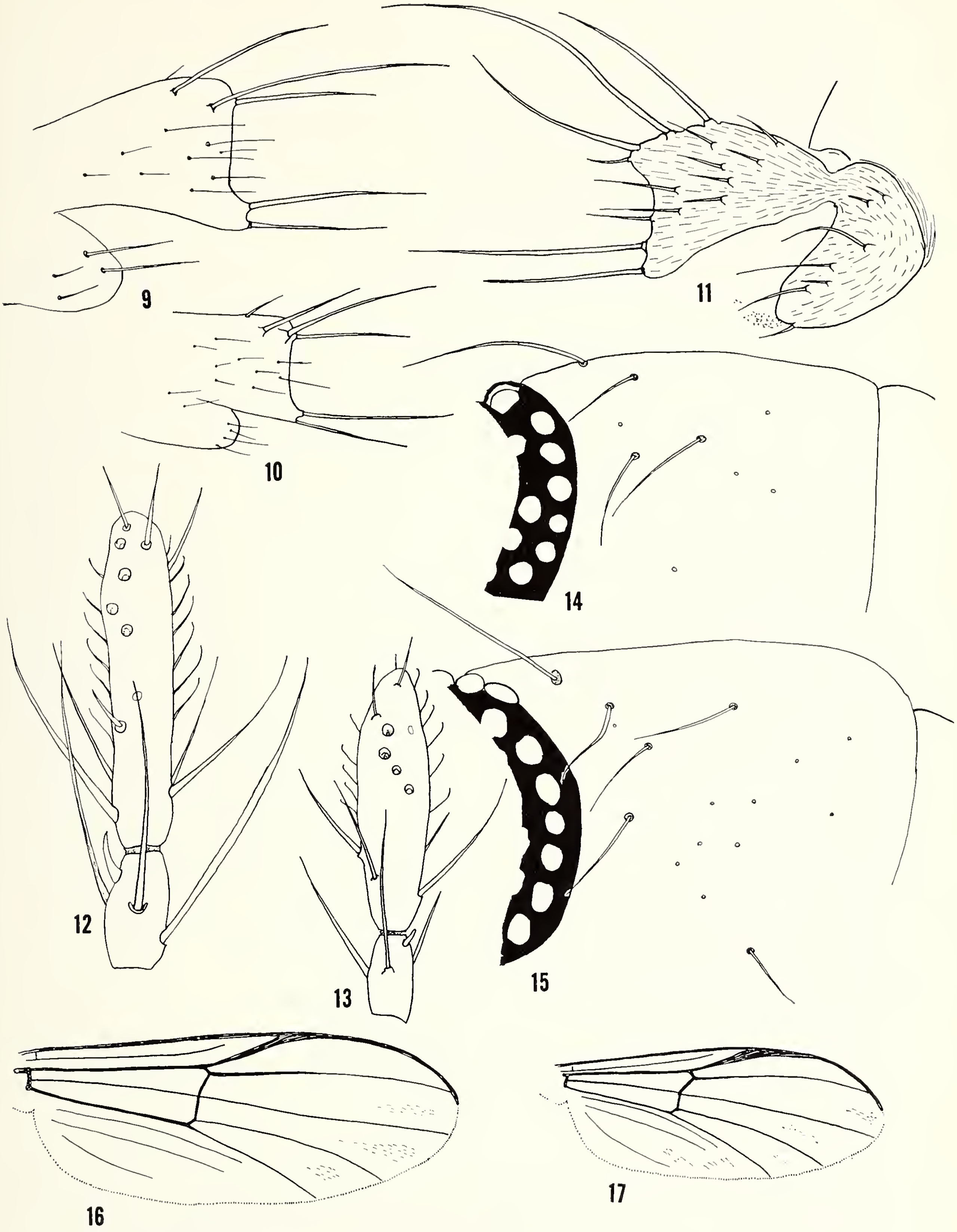
This species appears to be a member, though slightly aberrant, of the *albinervis* group of Brundin (1967). The male dististyle, in some aspects, combines characters of some members of the *decarthus* and *albinervis* groups. The subapical lobe, fig. 4, though smaller than most of those illustrated for the *decarthus* group, is larger than any in the *albinervis* group and lacks any microtrichia at its apex. In general form the dististyle is somewhat intermediate between that shown for *P. albinervis* (Brundin 1967, fig. 206) and *P. illesi* [S. Am.] or *P. derwentensis* [Tasm.] (loc. cit. figs. 190, 193). The subapical lobe of this species bears 3 "t" setae as does *P. derwentensis* and the "P" *seta* is longer than that of most members of the *albinervis* group.

The pupa, which keys to *Podonomus* sp. "La Paz" in Brundin 1967, is very typical of the *albinervis* group. If there were any doubts as to the placement of this species it would be resolved by the pupa. The form of the lateral abdominal spines, fig. 27 a–c, the pupal respiratory organ, figs. 21, 53, and the presence of a large ventral flap on abdominal segment 2, fig. 32, fit the characters of the *albinervis* group. In addition the female cerci, figs. 9, 11, are also typical of the *albinervis* group and are, in fact, very close to those of *P. albinervis*.

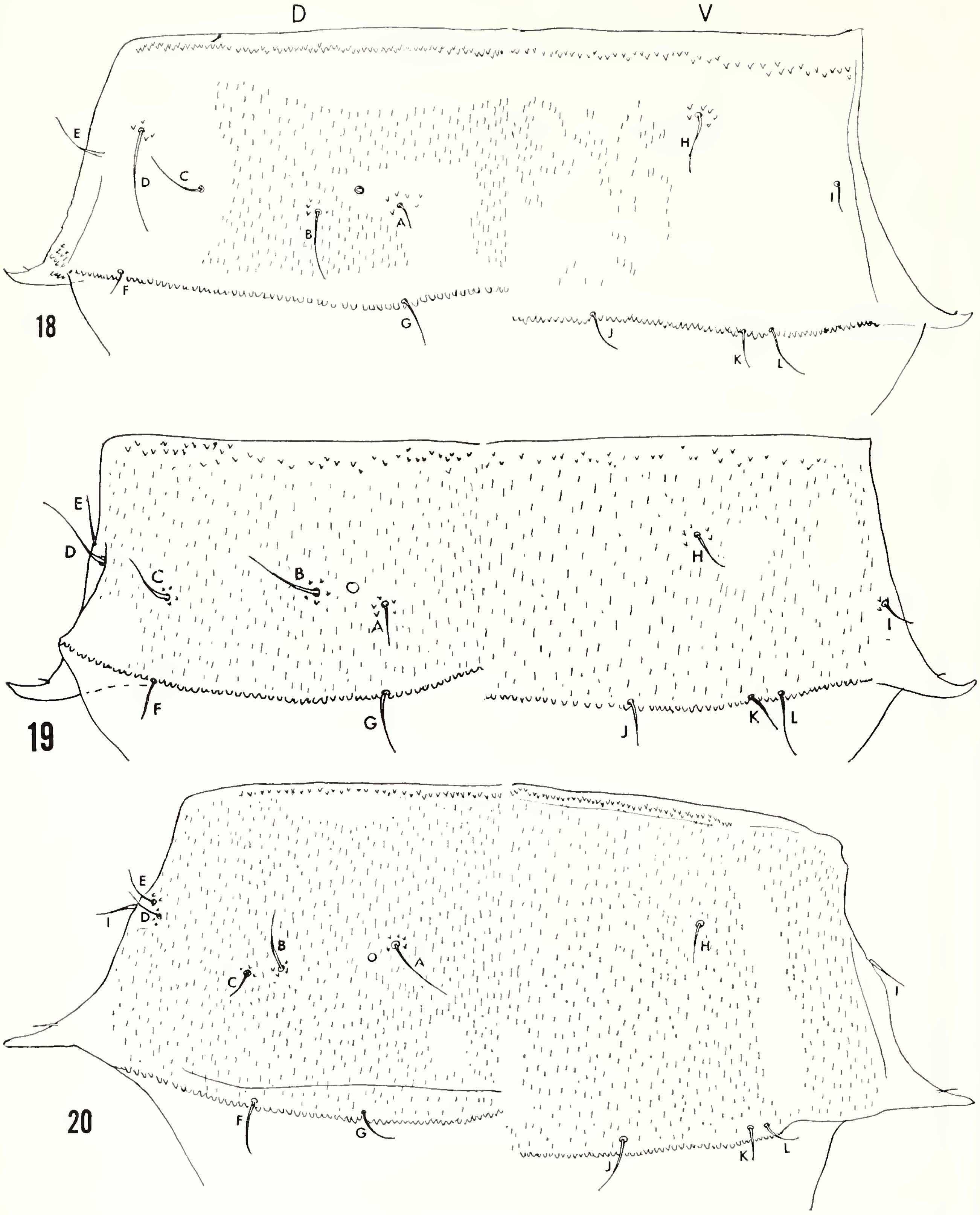
MALE: 1.9 mm. long, wing 2.0–2.1 mm.

HEAD. Brown; eyes bare; postoculars uniserial, extend onto vertex as in fig. 15; antenna 15 segmented (pedicel = segment 1); segments 2–13 with 2 verticels of long hairs each; scape and pedicel with 1–2 hairs each; last four segments in ratio 16-16-56-20; AR .47–.52; maxillary palpus appears four segmented; basal segment appears partially divided into small basal section with 1 ventral seta and distal section with a whorl of 3 setae; ratio 40 (10 + 30)—85-50-75; clypeus with 2–4 setae.

THORAX. Pronotum dark brown; reduced above; lateroventrals—4; mesonotum black-brown, vittae not too distinct; acrostichals, fig. 1; biserial with anterior hairs 58μ, caudal hairs 110μ; dorsocentrals also biserial with hairs 60 and 190μ long; humerals 4–6; supraalars 11–12; postalars 1; scutellar bristles—4 strong.



Figs. 9–17. *Podonomus* **caranqui**. Fig. 9—Female cercus, lateral. Fig. 11—Same ventrolateral. Fig. 12—apex of female antenna. Fig. 15—right half of female vertex. Fig. 16—female wing. *Podonomus* **quito**. Fig. 10—female cercus, lateral. Fig. 13—apex of female antenna. Fig. 14—right half of female vertex. Fig. 17—female wing.



FIGS. 18–20. Pupal sixth abdominal segment, dorsal view (D), ventral view (V). Fig. 18—*Podonomus* **caranqui**. Fig. 19—*Podonomus* **quito**. Fig. 20—*Podonomus* nr. *maorii*. Explanation of small A-L in text.

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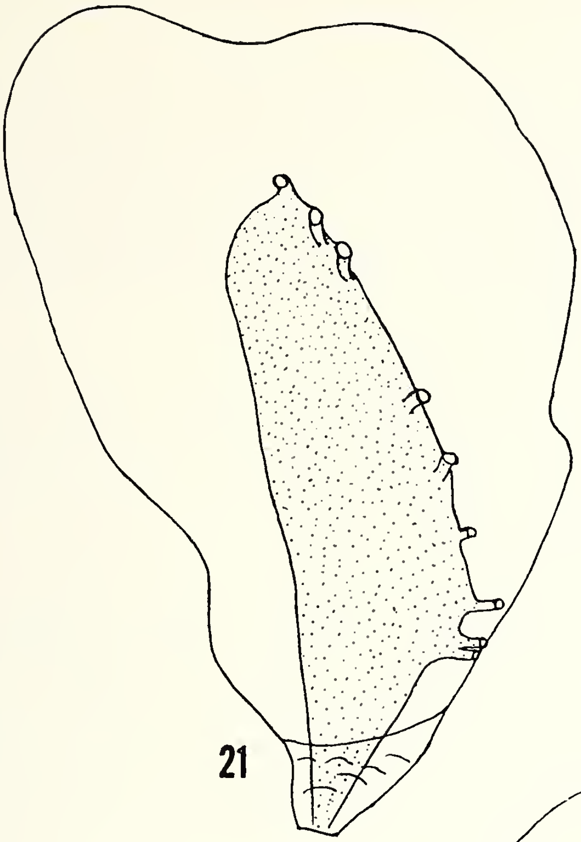
FIGS. 21–26. *Podonomus* **caranqui**. Fig. 21—Pupal respiratory organ, dorsal. *Podonomus* **quito**. Fig. 22—pupal respiratory organ, dorsal. Fig. 23—same, lateral. *Podonomus* m. *maorii*. Fig. 24—pupal respiratory organ, dorsal. Fig. 25—base of same, lateral. Fig. 26—Aeropyle openings at base of plastron, detail.



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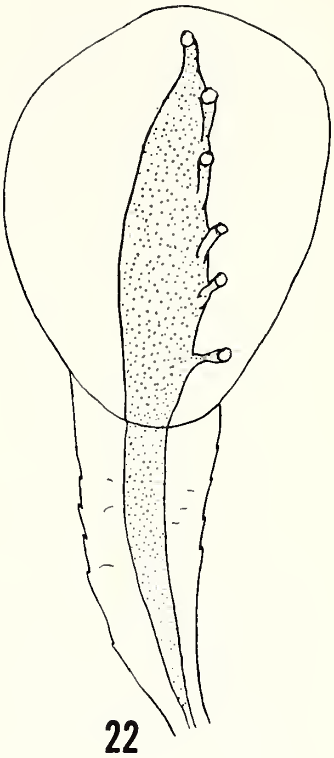

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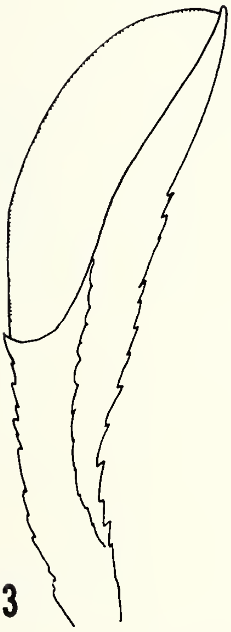

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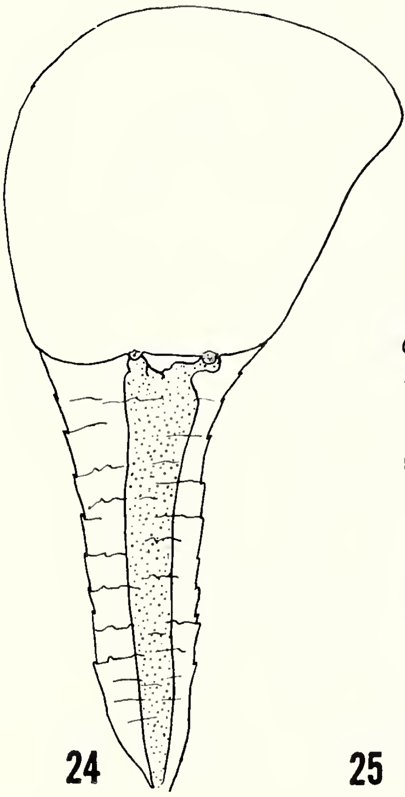

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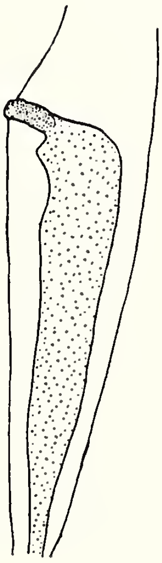

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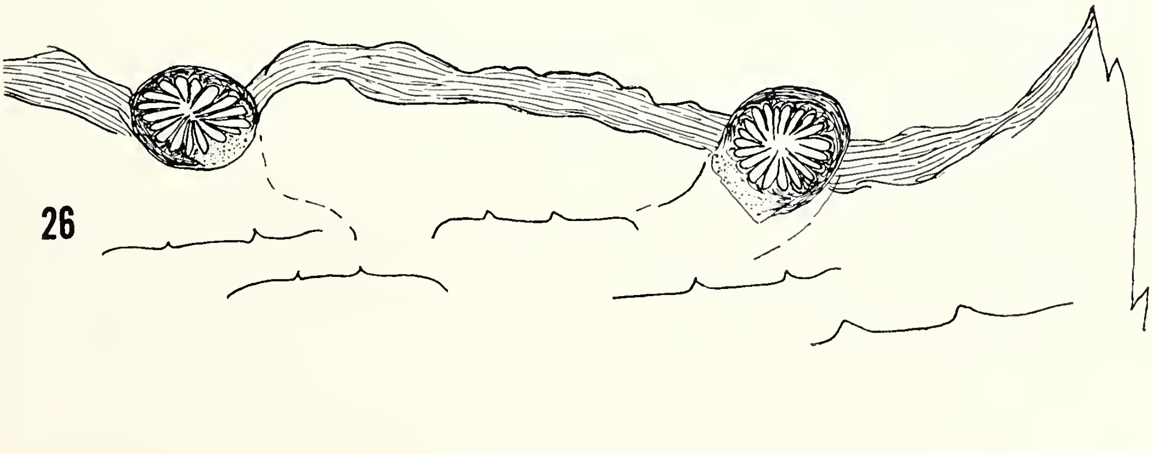

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WING. Only microtrichia on disc; RR .78; ARC .43; campaniform sensilla, fig. 36; venation as in fig. 16; costal extension past R_{4+5} 109μ;

LEGS. Black-brown; proportions given in table 1; LR I .53–.60; LR II .51–.53; LR III .50–.54; spur tibia I 51μ; spurs tibia II 41, 32μ; spurs tibia III 79, 38μ; spurs as in fig. 8, with numerous fine spines along shaft; apical 17 ± 1μ of each spur, regardless of total length, clear of fine spines; comb tibia III with 13 spines; T_4 with apical pad, fig. 3; claw spatulate, fig. 2, with one large filament at base; empodium well developed; small pulvilli present.

ABDOMEN. Black-brown; 9T with 32 ± bristles arranged 3-26-3;

GENITALIA. Basistyle, fig. 4, 160–167μ; 24 ± heavy bristles mesally; dististyle, fig. 4, 77–80μ; BR about 2.0; "t" seta of apical lobe 15–18μ long; subapical lobe broadly triangular with apex clear of microtrichia; 3 "t" setae, 11μ, present ventrally; "P" seta 58μ; "x" and "y" setae present, 11μ each; genitalic struts as in fig. 6.

FEMALE: 1.8–2.0 mm. long; wing 2.2 mm.

HEAD. Colored as male; vertex, fig. 15; small pits (10) on each side of vertex appear to be dermal gland canal openings, 0.60μ in diameter; antenna 10 segmented; ratio of segments starting with pedicel 45-30-28-22-22-23-22-22-24-75; average width of segment in same ratio 15; segments 2–9 with 1 verticel of long hairs and 1 basiconic receptor, 14–16μ long on each, fig. 12; AR .37; palpal segments in ratio 38-75-60-79; clypeus with 2 setae.

THORAX. Pronotum as male; humerals 11–12; supra-alars 16; other bristles as in male.

WING. Venation as in fig. 16; RR .81; ARC .40; some macrotrichia in cells R_{4+5}, M and Cu_1, campaniform sensilla as in fig. 36 except that sensilla in R_1 is closer to fR; costal extension 73μ.

LEGS. Black-brown; proportions and ratios in table 1; spur I 43μ; spurs II 41, 31μ; spurs III, fig. 8, 85, 42μ; comb III as male, claws sharp with 2 basal hairs.

ABDOMEN. Black-brown; 8S covered by mesally expanded hairs, fig. 7, 44–67μ long; these more concentrated around genital opening; cerci as in figs. 9, 11; longest 5 hairs from top to bottom 69, 107, 67, 73, 49μ; spermathecae about 47μ diameter; canal to genital opening elongate, transversely striate.

PUPA. 2.5–3.1 mm. long, figs. 47, 48; respiratory organ, figs. 26, 53, 370μ long by 222μ greatest width; in life, bright red-orange; stalk only 74μ long; plastron extends over both dorsal and ventral surfaces; dorsal plastron slightly wavy with a slight fold along line of aeropyles, fig. 53; ventral plastron shallowly v-shaped with a mesal longitudinal ridge; details of plastron structure, figs. 54–58; respiratory atrium as in figs. 21, 59; opens to plastron through about 9 aeropyles, fig. 21; there is some variation in number and detailed distribution; internally atrium with a fine structural meshwork, fig. 60; ventral flap of abdominal segment 2, fig. 32, 177μ long along midline; flap is .83 length of segment 3; microsculpture of abdominal segments as in fig. 18; lateral spines present

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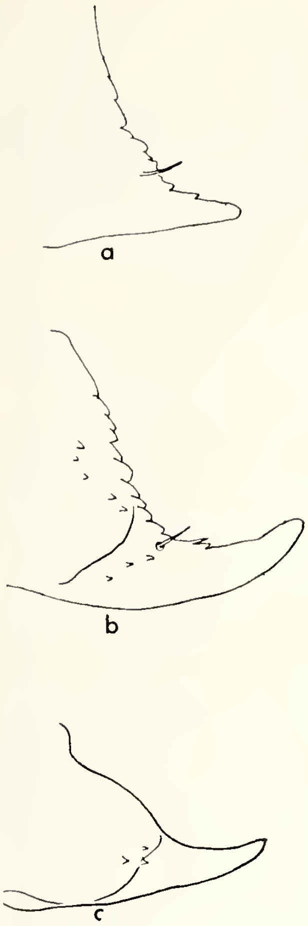
FIGS. 27–35. *Podonomus* **caranqui** pupa. Fig. 27a–c—lateral spines of abdominal segments 4, 7, 8. Fig. 30—detail of ventral hair H, sixth abdominal segment. Fig. 31—detail of dorsal hairs A, B, sixth abdominal segment. Fig. 32—ventral flap of second abdominal segment, lateral. Fig. 35—anal fins, right half. *Podonomus* **quito** pupa. Fig. 28a–c—lateral spines of abdominal segments 4, 7, 8. *Podonomus* m. *maorii* pupa. Fig. 29a-c—lateral spines of abdominal segments 4, 7, 8. Fig. 33—anal fins. Fig. 34—detail of anal spurs.



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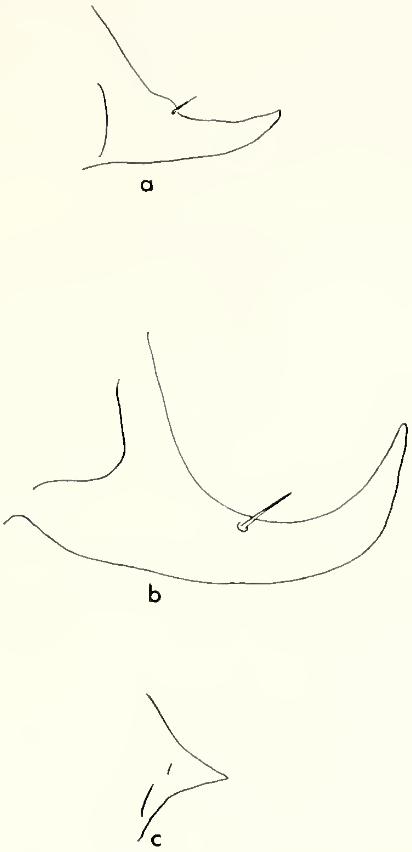

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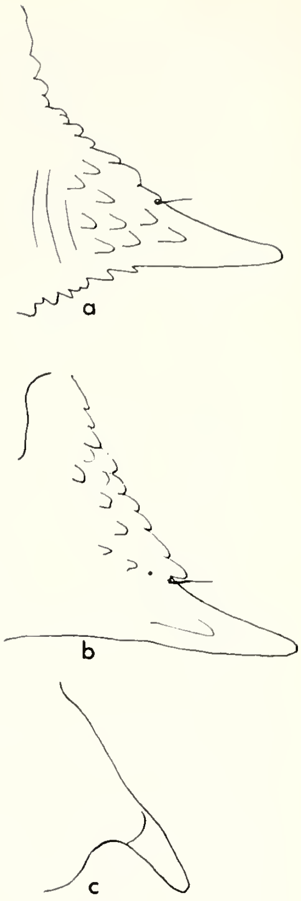

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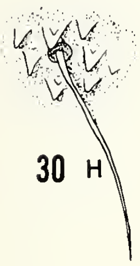

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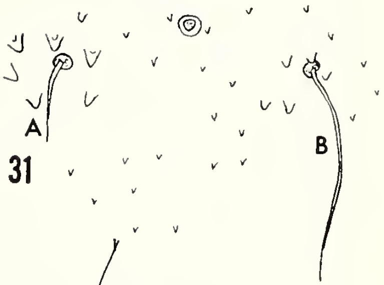

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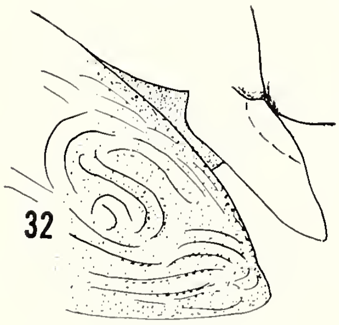

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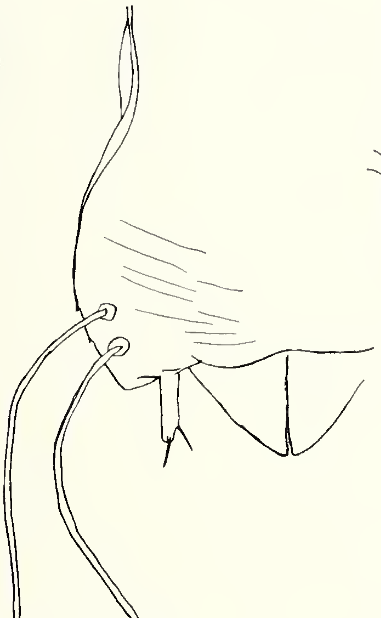

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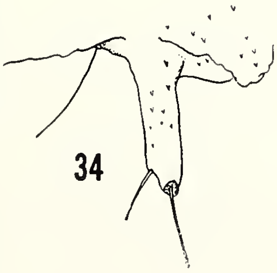

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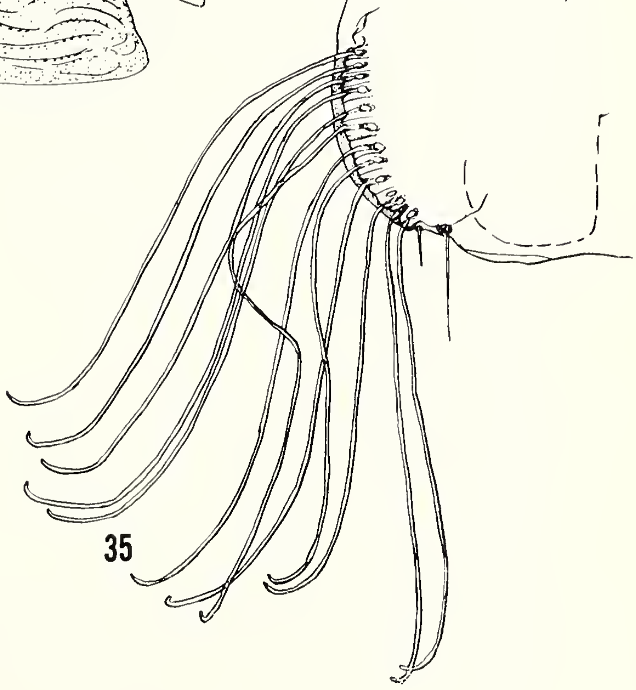

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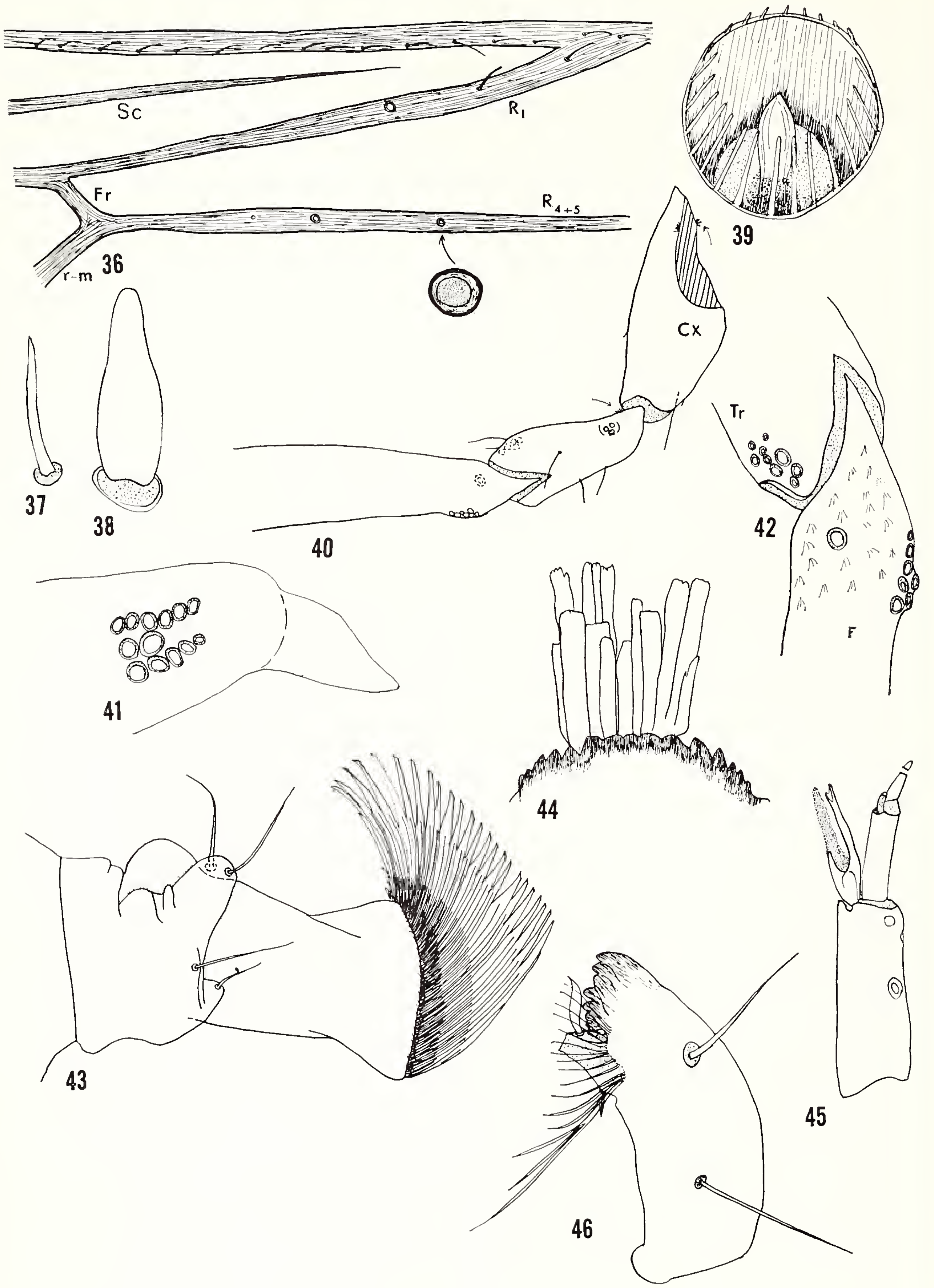


Figs. 36–46. *Podonomus* **caranqui**. Fig. 36—detail of radial sector with campaniform sensilla. Fig. 37—chemoreceptor, apical segment male antenna. Fig. 38—Chemoreceptor, flagellar segments 2, 3, male antenna. Fig. 41—detail coeloconic receptor, apical segment male antenna. Fig. 41—detail venter of base of femur. *Podonomus* **quito**. Fig. 40—coxa,

on segments 3–8; those on 3–7 similar to figs. 27 a, b; spine on 8 as in fig. 27c; abdominal chaetotaxy of intermediate segments, fig. 18; lengths of setae given in table 2; a small "O" seta (4.7μ) seems to be present; tergites 2–7 with a campaniform sensilla (4.5μ diameter) between setae A & B, fig. 31; 2 such sensilla on each side of tergite 1; major dorsal and ventral setae each surrounded by a ring of blunt heavier spines, figs. 30, 31; segment 8 with 8 lateral wavy hairs; anal segment with 12, fig. 35; wavy hairs about 330μ long; anal spurs reduced, fig. 35; a pair of hairs 20 and 70μ long at this spot on each side.

MATERIAL EXAMINED

HOLOTYPE. ♂ on slide; Ecuador, Prov. Cotopaxi, 3,500 m. Road Pujili-Quevedo, Rio Sumbahua, July 29–Aug. 15, 1969 Coll. P. & B. Wygodzinsky (AMNH)

ALLOTYPE. ♀ on slide, same data as holotype (AMNH)

PARATYPES. ♂, 2♀♀ in alcohol, (AMNH), ♂ on slide (ANSP), ♂ on slide (AMNH) ♂, ex pupa on slide (AMNH), same data as holotype Numerous pupae and pupal skins

Podonomus **quito** new species

The male dististyle of this species, fig. 5, (dissected from mature pupa) appears close to that of *P. inermis* Brundin, *P. paynensis* Brundin and *P. nordenskjoldi* Brundin. The male, as far as could be discerned, differs from *P. inermis* in lacking a narrowed tip of the last antennal segment; from *P. paynensis* in its smaller size and lack of stout setae on the basistyle; from *P. nordenskjoldi* in having a normal, not reduced, antennal plume. The pupal respiratory organ differs, figs. 22, 61, from any figured by Brundin (1967) for the *albinervis* group.

The female cercus resembles that of *P. inermis* but differs in the straight dorsal margin and lacks the setal tuft on the lower lobe of the *P. inermis* cercus.

MALE: dissected from mature pupa.

HEAD. Chaetotaxy as in female; antennal plume normal; apical segment not narrowed; apical antennal segments (teneral) in ratio 24-20-85-52; sensilla as in *P.* **caranqui**; clypeus with 6 setae; pedicel and scape, 1 seta each.

THORAX. Does not appear to differ from *P.* **caranqui** in color or chaetotaxy.

WING. Not fully developed.

LEGS. Spur tibia I 37μ; spurs II 27, 23μ; spurs III 63, 32μ; claws, pad of T_4, distribution of leg sensilla as in *P.* **caranqui**.

GENITALIA. Basistyle, fig. 5, with only fine setae; length about 95μ; dististyle about 58μ; "t" seta of apical lobe 14μ; subapical lobe not clearly present; entire dististyle covered with microtrichia.

←

trochanter and base of femur, leg I, anterior view, tonic receptor hair patches indicated by arrows. Fig. 42—detail of base of femur, apex of trochanter, posterior view. Fig. 43—larval posterior proleg, dorso-lateral. Fig. 44—larval labial plate and hypopharyngeal blades. Fig. 45—antenna. Fig. 46—mandible.

TABLE 1. Proportions of leg segments and leg ratios.

Leg	F	Ti	T_1	T_2	T_3	T_4	T_5	LR
Podonomus **caranqui**					MALE			
I	170	175	100	45	30	17	17	.57
II	180	161	85	45	26	15	17	.53
III	210	220	110	65	32	14	17	.50
					FEMALE			
I	150	157	95	55	28	16	17	.61
II	150+	152	75	43	25	14	16	.49
III	—	185	100	65	32	15	17	.54
Podonomus **quito**					FEMALE			
I	115	111	65	36	20	11	13	.59
II	134	114	53	31	18	12	14	.46
III	195	152	75	48	23	12	14	.49

FEMALE: 1.6 mm; wing 1.7 mm.

HEAD. Black-brown; eyes bare; postoculars uniserial, extend on to vertex as in fig. 14; 5–6 gland openings on each side of vertex; antennal segments in ratio 28-27-19-19-18-19-19-19-55; pedicel in same ratio-35; antennal ratio .32; last two antennal segments, fig. 13; palpal segments in ratio 32 (10 + 22)—55-45-60; basal segment appears partially divided into a short basal part with 1 latero-ventral bristle and a longer apical section with a whorl of 4 bristles;

THORAX. Pronotum black-brown; 3 latero-ventrals; acrostichals as in male of *Podonomus* **caranqui**; humerals 14; supra-alars 10; postalars 1; scutellars 4; vittae not distinct.

WING. Venation as in fig. 17; RR—.62; ARC—.34 macrotrichia only in cells, R_{4+5}, M, Cu_1, and behind Cu_2; costal extension 76μ.

LEGS. Brown; proportions and ratios given in table 1; spur I 29μ; spurs II 32, 23μ; Spurs III 62, 26μ; comb tibia III, 13 setae; leg sensilla, figs. 40, 42, same as for *Podonomus* **caranqui**; claws apically sharp with 2 basal spines.

ABDOMEN. Black-brown with usual scattered bristles; spermathecae (2) ovoid, 38 × 56μ; brownish with apical 13μ clear; 8S with bristles on disc and around genital opening as in *Podonomus* **caranqui**, fig. 7; cercus as in fig. 10; five longest hairs top to bottom 42, 66, 53, 57, 37μ.

PUPA. 1.9–2.3 mm. long, figs. 49–52, respiratory organ, figs. 22, 23, 61, 276μ long by 148μ greatest width; in life, bright red-orange; plastron 162μ long; stalk 114μ; plastron, figs. 61–64, only on dorsal surface, moderately convex and smooth; details of the plastron structure shown in figs. 62–64; respiratory atrium, fig. 22, opens to plastron through 6 aeropyles; there is some variation from specimen to specimen; venter of respiratory organ with flat spines as on dorsal side of stalk, fig. 64; ventral flap of abdominal segment 2 166μ; .90 length of segment 3; microsculpture of mesal abdominal segments as in fig. 19; lateral spines on abdominal segments 3–8; those on 3–7 as figs. 28 ab, spine on segment 8 very small and triangular in shape, fig. 28 c; abdominal chaetotaxy of intermediate segments as in fig. 19; lengths of setae given in table 2; small "O" setae and campaniform sensilla present on tergites as in *Podonomus* **caranqui**; spines around abdominal setae not as well developed as in *Podonomus* **caranqui**; abdominal segment 8 with 12 wavy hairs; anal segment with 14, wavy hairs about 325μ; anal spurs reduced similar to fig. 35; setae 23 and 86μ on each side.

Table 2. Lengths in μ of setae of sixth pupal abdominal segment. As did Brundin (1967), I found it impossible to, with certainty, homologize the dorsal and ventral setae of the podonomine pupal abdomen with those of the Tanypodinae (Fittkau 1962). I have designated these setae in figs. 18–20 with the letters A–L and have above suggested possible homologies with those of Fittkau. No "O" setae could be discerned on *Parochlus* nr. *maorii.*

Possible Homology[1]	seta	*P.* **caranqui**	*P.* **quito**	*P.* nr. *maorii*
D_5	A	26	20	37
D_3	B	51	39	29
D_1	C	44	31	14
D_2	D	66	39	22
L_1	E	44	29	22
	F	13	17	32
	G	36	32	19
V_1	H	44	19	22
L_2	I	19	19	22
	J	20	25	29
	K	15	25	14
	L	22	38	14
O		4	4	—

[1] Fittkau (1962), p. 97, fig. 10.

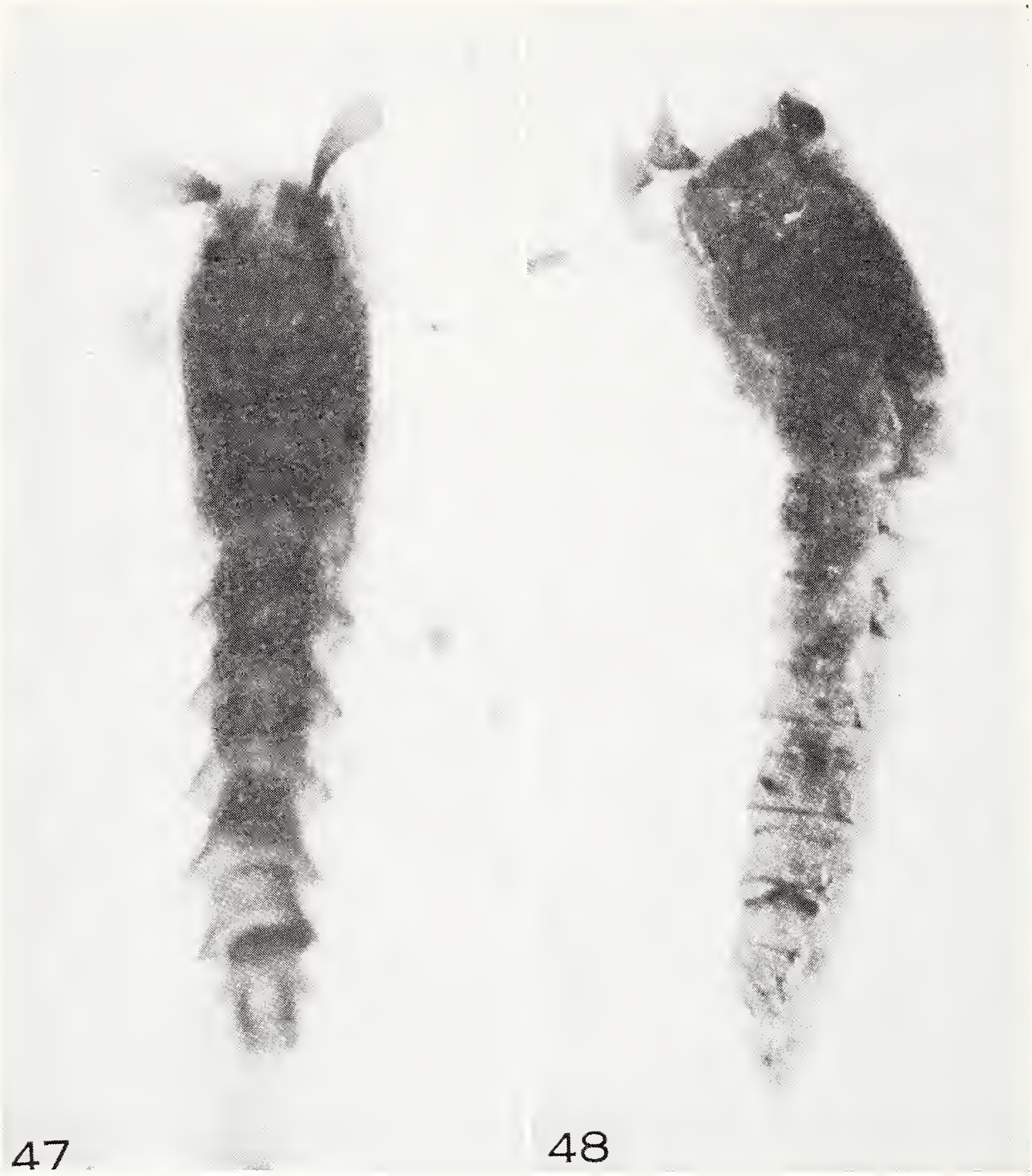
LARVA: Head black-brown; anteriorly narrowed, triangular in shape in dorsal view; 320μ long by 170μ at widest point (about .16 from caudal margin); antenna, fig. 45, four segmented; ratio 40-19-7-2; membranous blade extends from unequally bifurcate sclerotized base; shorter fork 17μ, blade extends from 16μ beyond this; longer sclerotized fork (nebenborste?) 32μ; slightly curved rod, 6μ at apex of segment 2, with a membranous apex; sense pit 11μ in diameter .5 from base of segment 1; 2 light areas of unknown function near apex, each 4μ in diameter; mandible, fig. 46, 91μ long; mandibular comb of 15–16, filaments, 19–58μ in length; accessory tooth 15μ long; maxillary palpus 15μ wide, tapers from 14–7.3μ in length; labial plate fig. 44, with 15 teeth; hypopharyngeal lamellae (13–14) 48–73μ long, some apically incised; body with brownish pigment; abdominal segments with 2 transverse circles of long setae each about .25 from nearest end of segment; 2 trifurcate short hairs on each side and a few additional setae, anteriorly; anal papillae (brush pedestal) black, slightly curved, 122μ long by 33μ wide; with one dark anteromesal hair, 185μ long and one light apicocaudal hair 55μ long; apical bristles (7) black, 204μ; posterior prolegs, fig. 43; claws in four ranks—131, 102, 36 and 17μ long; a few longer claws, 138μ present; anal gills (4) ovoid, 11 × 52μ.

MATERIAL EXAMINED

HOLOTYPE. ♂ ex pupa on slide, Ecuador, Prov. Cotopaxi, 3500 m. Road Pujili-Quevedo, Rio Sumbahua, July 29–Aug. 15, 1969 Coll. P. & B. Wygodzinsky (AMNH)

ALLOTYPE. ♀ on slide, same data as holotype (AMNH)

PARATYPES. ♂ ♀, ex-pupa, on slide (ANSP)—♀ in alcohol (AMNH), ♀ in alcohol, genitalia on slide (AMNH)—same data as holotype
Approximately 26 pupae and numerous larval skins.



FIGS. 47–48. *Podonomus* **caranqui** pupa. Fig. 47—dorsal. Fig. 48—lateral.

Parochlus nr. *maorii* Brundin 1967

Only a single cast skin of this species was found in the collection. In Brundin's 1967 key to the pupae of this genus it keys to the New Zealand species *Parochlus maorii* Brundin in the *araucanus* subgroup. It differs from *P. maorii* only in the more angulate shape of the plastron and the five wavy setae on the eighth abdominal segment. According to Brundin, *P. maorii* pupae are so variable that even these differences may not be meaningful. In South America, this

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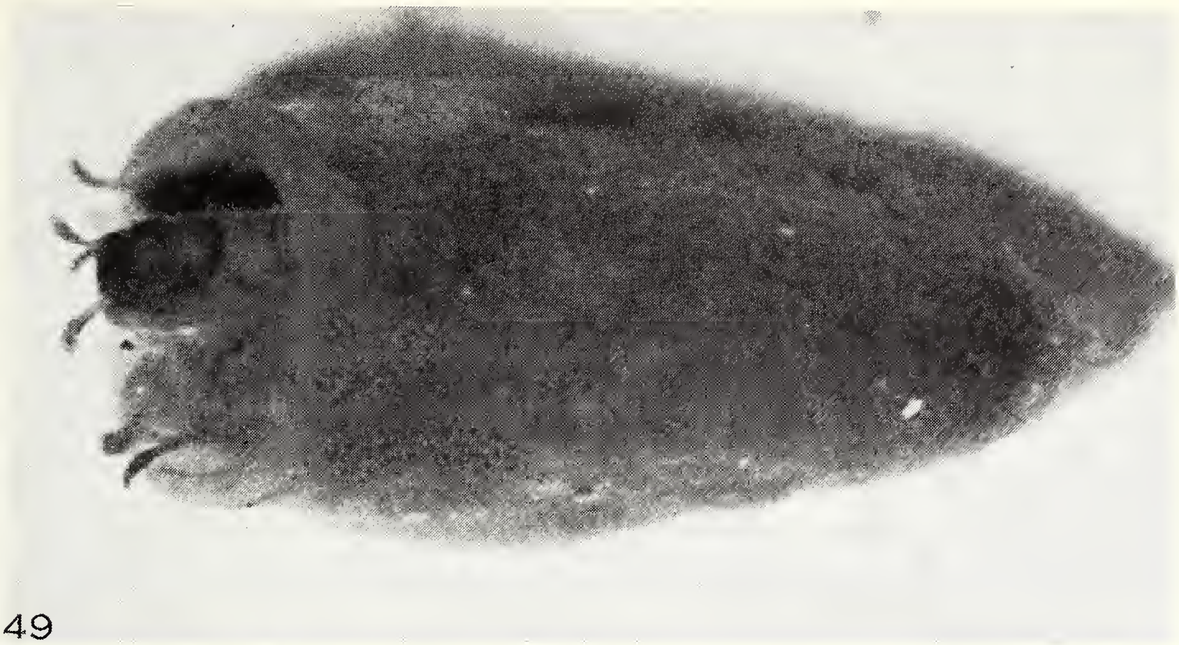
FIGS. 49–52. *Podonomus* **quito**. Fig. 49—Simuliid puparium with enclosed *Podonomus* **quito** pupae, dorsal. Fig. 50—same, ventral. Fig. 51—pupa, dorsal. Fig. 52—pupa, lateral.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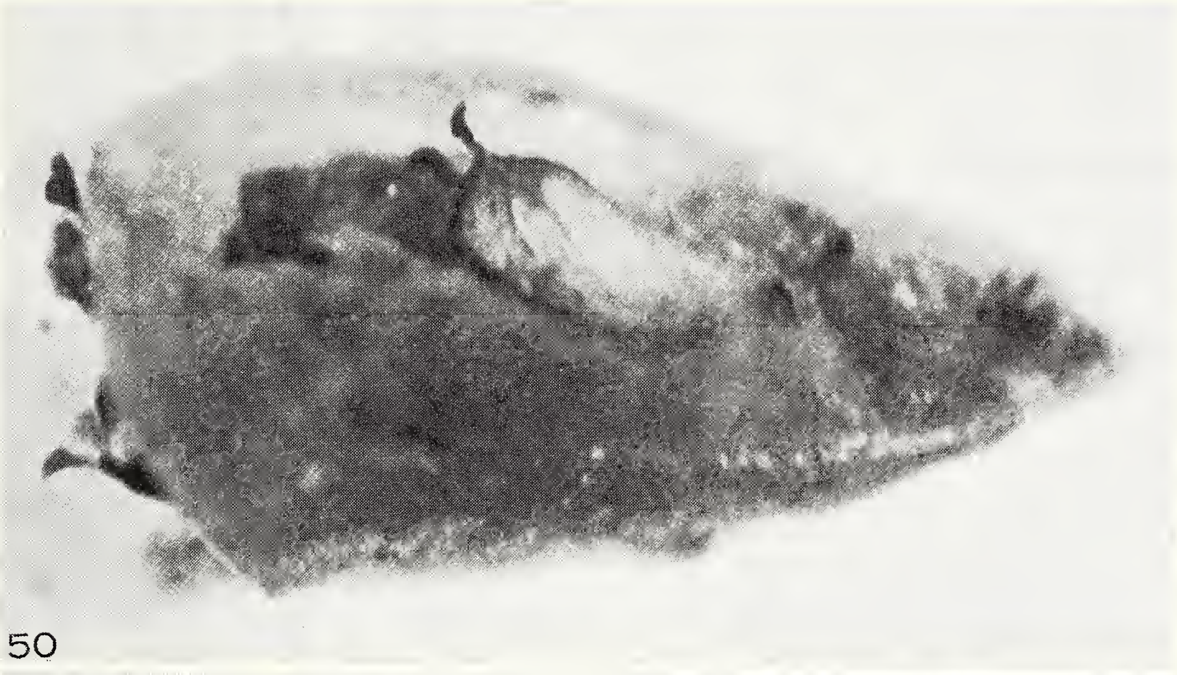
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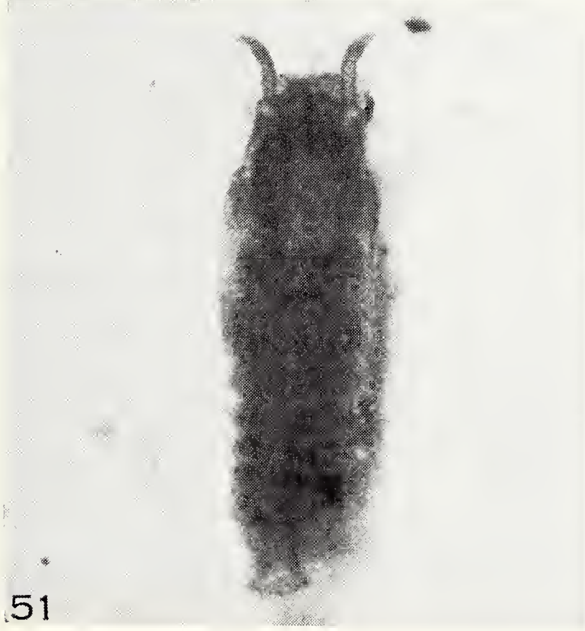
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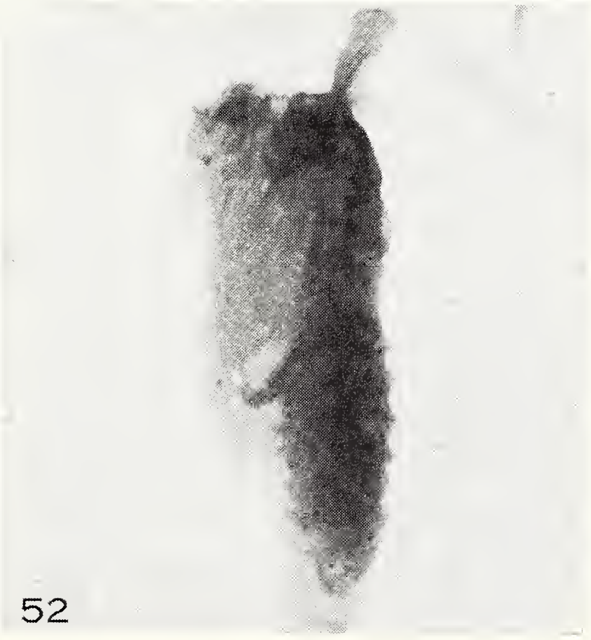
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species is the most northerly of the *Parochlus* species. Except for *P. incaicus* Brundin, from Peru and Bolivia most South American *Parochlus* are South Andean, Chilean or Patagonian in distribution. It is much closer to *P. maorii* and *P. araucanus* than to the Holarctic *P. kiefferi.*

PUPA. Respiratory organ, figs. 24, 25, 344μ long; plastron 159μ on dorsal surface only; stalk 185μ with plate-like spines; greatest width of plastron 148μ; horn sac not discernible; spiracular atrium extends to base of plastron, opens into plastron by means of two aeropyles, fig. 26, set in basal ridge of plastron; ventral flap of abdominal segment 2, 56μ long at midline; about .25 length of segment 3; microsculpture of abdominal tergites as in fig. 20, moderate; not as well developed on intersegmental membranes; lateral spines on segments 3–8; those on segments 3–7 as in figs. 29 a, b; laterally directed spine of segment 8, 29μ; caudolaterally directed, fig. 29c; abdominal chaetotaxy of intermediate segments as in fig. 20; lengths of setae given in table 2; segment 8 with 5 wavy hairs, anal segment with 2, fig. 33; hairs 280–330μ; anal spur figs. 33, 34, slightly rugose, caudally directed, 38μ long; apical seta 20μ on one spur, 23μ on other; lateral seta 20 and 17μ long.

MATERIAL EXAMINED. 1 pupal cast skin—Ecuador, Prov. Cotopaxi, 3500 m. Road Pujili-Quevedo, Rio Sumbahua, July 29–Aug. 15, 1969, Coll. P. & B. Wygodzinsky (AMNH)

SENSILLA

CHEMORECEPTORS

Both basiconic and coeloconic receptors are found on the antennae of the adults of the *Podonomus* species examined. One receptor, apparently basiconic, fig. 37, was found on the apical antennal segment of both sexes. It is 7.8μ long. A larger but similar receptor, fig. 38, 12μ long, was found on the lateral apex of flagellar segments 2, 3 of the male antenna and on flagellar segments 1–8 of the female antenna with a size range of 11–15μ, figs. 12, 13. Both the aforementioned figures also show the slightly hooked, thin walled hairs, 14.6μ long, present on the apical antennal segments. Their nature is not clear, without stained sections one cannot say whether they are chemoreceptors or tactile setae.

The coeloconic receptors are present on the apical segments of the male and female antennae, figs. 12, 13, 4–5 on each. One was also present at the apex of the preapical segment of the male antenna. Those sensilla consist of a short peg at the bottom of a parallel sided or slightly tapering depression, fig. 39. The surface opening is about 5μ in diameter and is fringed with upright filaments, 2.4μ long. The depression is not as sheltered as those illustrated for the Orthoptera and Sarcophagidae but undoubtedly the filaments serve the

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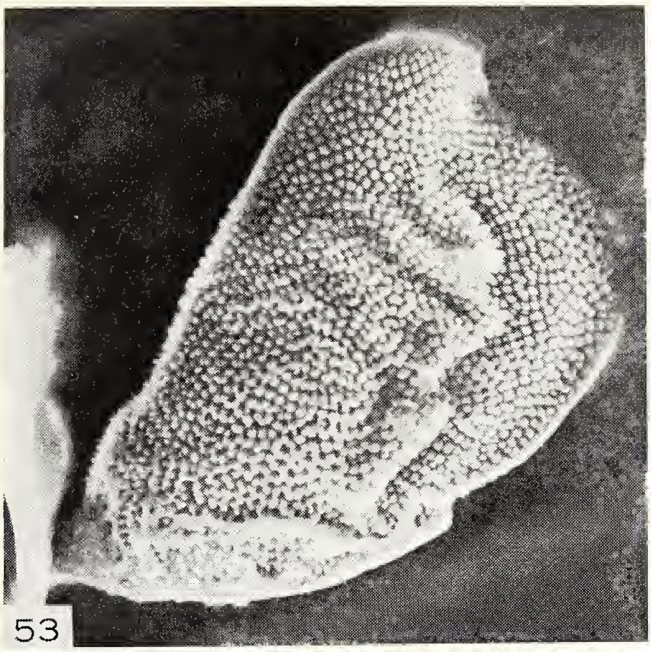
Figs. 53–58. *Podonomus* **caranqui**. Pupal respiratory organ, electron photomicrographs. Fig. 53—entire organ, 275×. Fig. 54—plastron 2000×. Fig. 55—detail of plastron tubercles, 9,000×. Fig. 56—plastron tubercle 20,000×. Fig. 57 plastron at dorsal fold, 2,000×. Fig. 58—plastron at right side notch, 2,500×.



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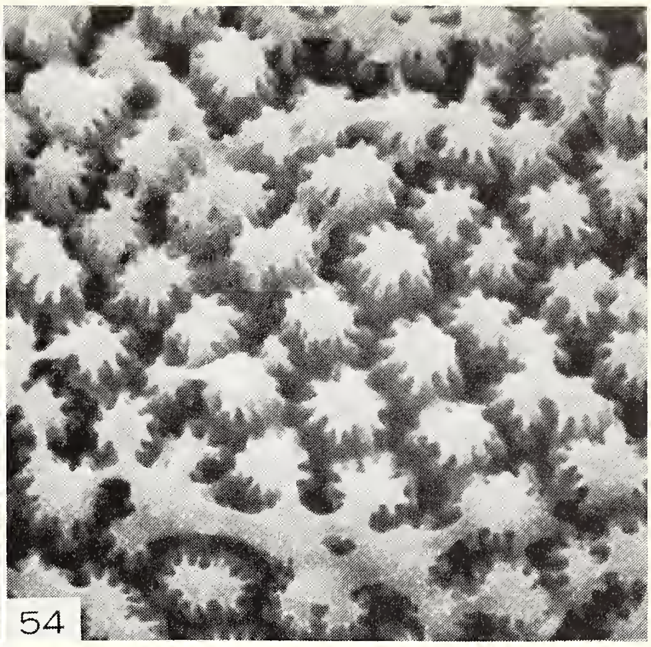

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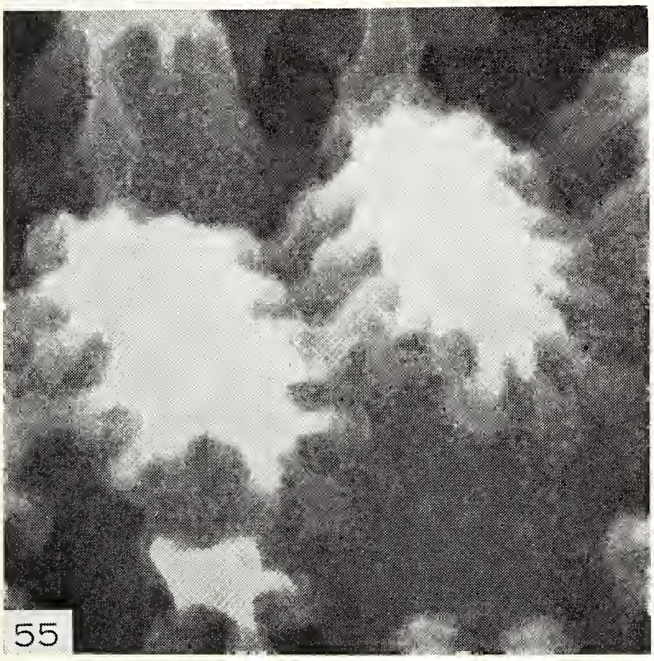

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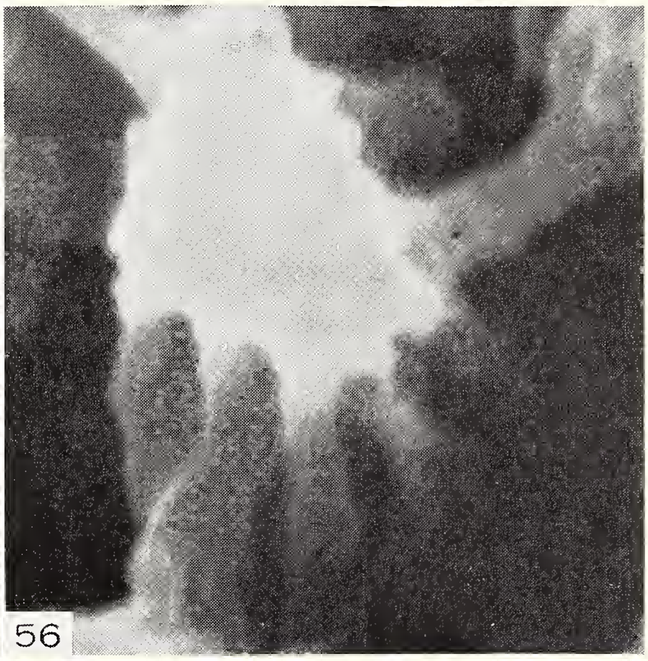

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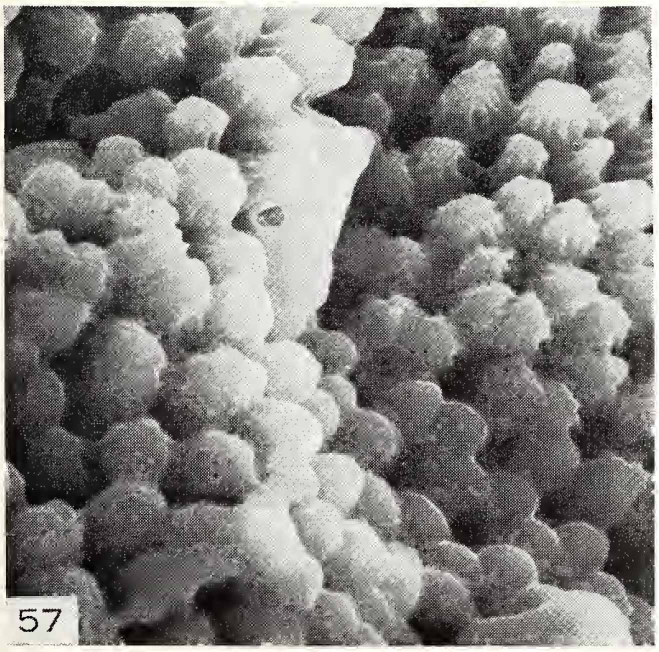

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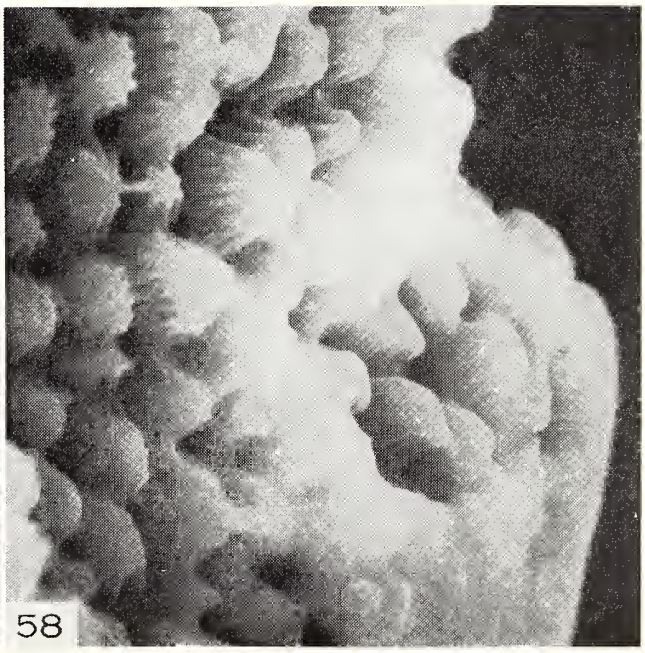

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same function as the covering or the spines in those groups (Slifer et al. 1959, Slifer and Sekhon 1964).

MECHANORECEPTORS

Campaniform sensilla, in addition to those on the halteres, are found on the wings and legs of the *Podonomus* adults and the pupal abdominal tergites. On the wings of both species here described there is one sensilla on R_1 and 2 or 3 on R_{4+5}, fig. 36. These are about 7μ in diameter. On the female, the sensilla on R_1 is closer to fR than in the male, fig. 36. One female specimen had a campaniform sensilla in the membrane below Sc, 145 distad of the arculus. The basal vein of both sexes of both species had 8–9 campaniform sensillae. Saether (1969) mentions that the Podonominae have in total 3–4 sensory organs on the wing—these located near r–m, fR or proximally on R_{4+5}. On the legs 4–5 of these sensilla are found scattered in the basal .25 of the tibiae; a distinct patch of 13, figs. 40, 41, on the base of F and a single sensilla caudally above this patch; in distinct groups of 9 at the apex (caudally) and 3 at the base (anteriorly) of the trochanter, figs. 40, 42. There are none on the tarsal segments. Pringle (1938a) reports them for the Orthoptera.

Tonic receptors, consisting of beds of 4–7 hairs about 6μ long are present on the trochanter at the dorsal edge of its base and on both sides of the base of the coxa (see arrows on fig. 40). In both cases they would function as proprioceptors, being stimulated by contact with the adjoining apex of coxa and cuticle of the pleuron respectively, Pringle (1938b).

In addition to those on the adult, small campaniform sensilla appear to be present between hairs A & B on each side of abdominal tergites 2–7 of the pupa, figs. 18–20, 31. These are $4–5\mu$ wide. On the first tergite there are two on each side. These campaniform sensilla may be associated with the "walking" habit of these podonomine pupae. The ability to sense the flexing of the tergites would be of value to a pupa trying to hold on to or move on a rock in a torrent or to locate itself in a simuliid pupal case. To the best of my knowledge the pupae of the Tanypodinae, Orthocladiinae, and Chironominae which swim or flip about in the water, lack these campaniform sensilla.

THE PLASTRON OF *Podonomus* AND THE TANYPODINAE

The plastron in *Podonomus* **caranqui** covers most of the dorsal, fig. 53, and ventral surface of the pupal respiratory organ. As can be seen in figs. 55–56 the individual components of this plastron consist of dorsally rugose, laterally

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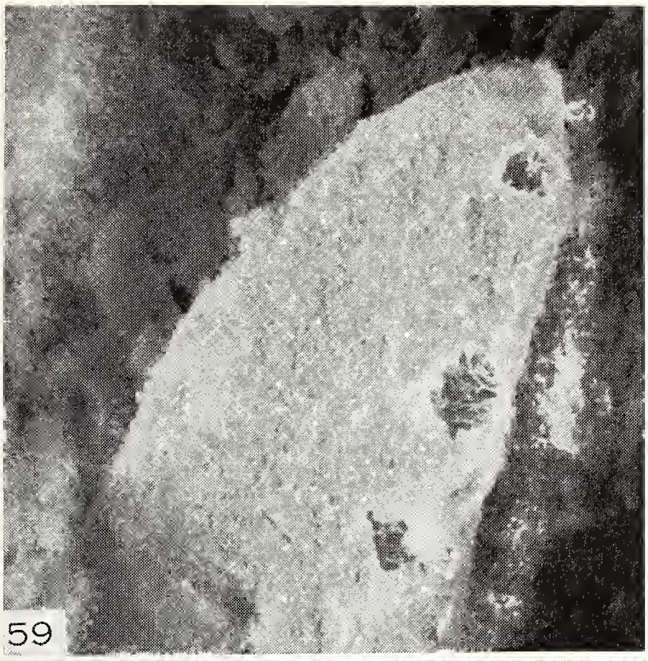
Figs. 59–64. *Podonomus* **caranqui**. Electron photomicrographs. Fig. 59—dorsal view of spiracular atrium-holes are removed aeropyle tubes, 1500×. Fig. 60—detail of aeropyle tube exit hole, 10,000×. *Podonomus* **quito**. Fig. 61—pupal respiratory organ, 325×. Fig. 62—plastron, 2,000×. Fig. 63—detail of lower edge of plastron and top of stalk 2,000×. Fig. 64—apex showing plastron and ventral surface of respiratory organ.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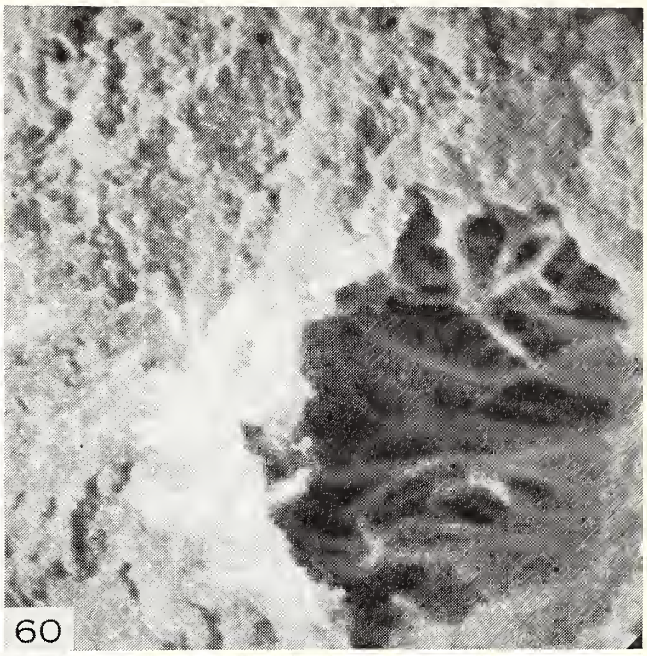
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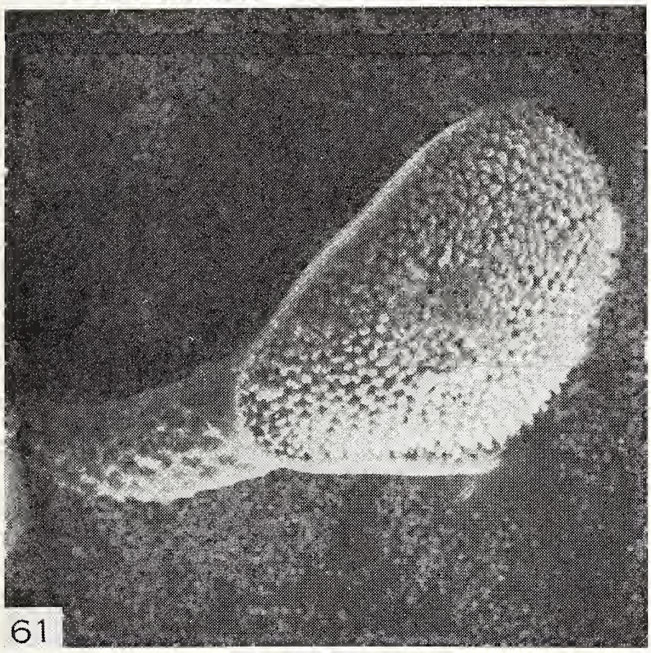
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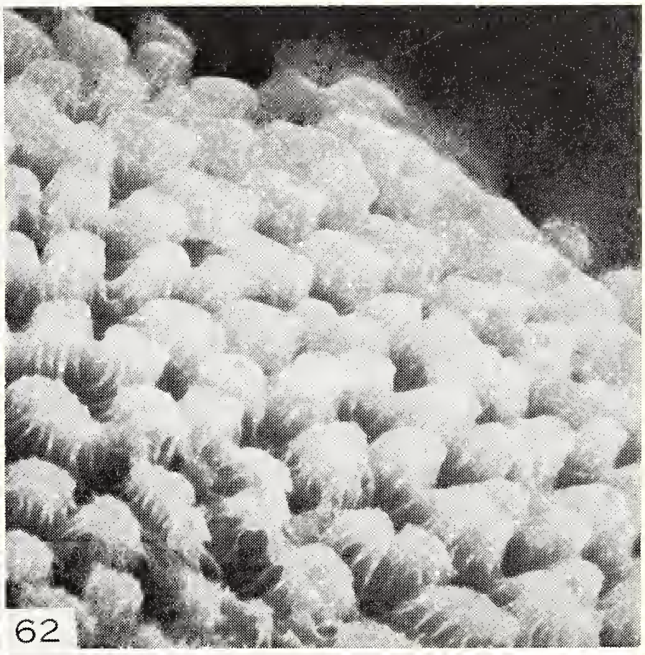
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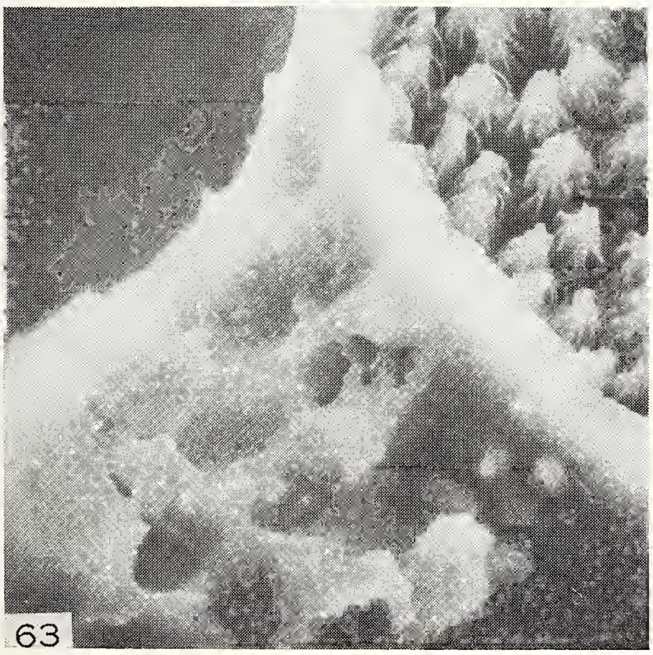
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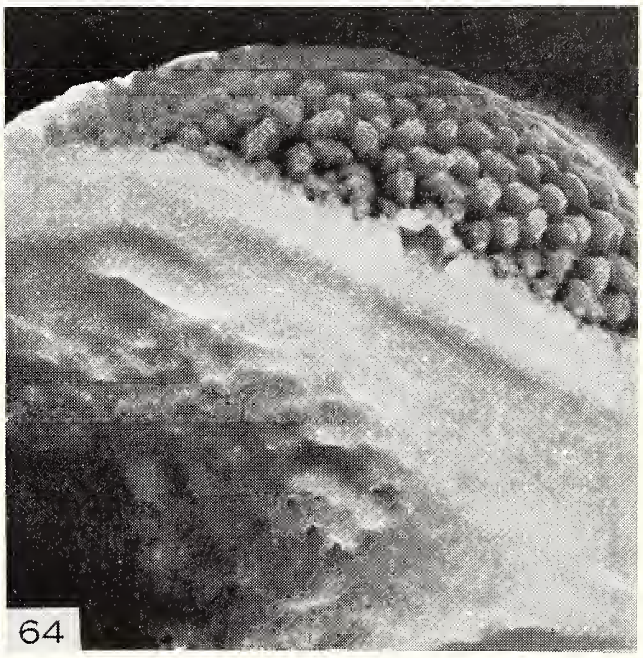
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eroded islands. As far as could be seen, there do not appear to be any open spaces under the islands of the plastron. These may be connected at their bases, figs. 55, 56 or dorsally to form a mesh. This interconnection as well as a more lateral view of the plastron components is shown in figs. 57, 58. Figure 57 was taken along the fold containing the aeropyles and fig. 58 at the notch in the right hand margin. In fig. 59 the dorsal plastron has been removed, exposing the respiratory atrium. In removing the plastron the aeropyle tubes were torn away revealing the interior of the atrium. The network of cuticular struts, which strengthen the atrium against collapse can be seen in fig. 59 and in more detail in fig. 60.

As can be seen in figures 61, 63, 64 the plastron of *Podonomus* **quito** is restricted to a dorsal ovoid, convex area. The individual island are similiar to those of *Podonomus* **caranqui** but are slightly convex apically and more finely eroded laterally. There appear to be some open arches extending from these islands, fig. 63. The surface of the stalk of the respiratory organ is scale-like, fig. 63, or smooth toward the ventral apex, fig. 64.

Superficially the plastron of *Paulianina pamela* Stuck. [Blepharoceridae] as illustrated by Hinton (1968) appears similar. Hinton has pointed out that similar plastron components appear to have arisen several times, independently, in the aquatic insects and this resemblance does not necessarily imply any relationship.

Brundin (1967) considered the Tanypodinae to be the "sister group" to the Podonominae and the availability of the scanning electron microscope provided me with the opportunity to examine the plastron of representative tanypodine genera. The respiratory organ of representatives of the Coelatanypodini (*Clinotanypus pinguis* Loew), Tanypodini (*Tanypus carinatus* Subl.), Macropelopiini (*Psectrotanypus dyari* Coq. and *Procladius* sp.) and *Pentaneurini* (*Conchapelopia* sp., *Ablabesmyia mallochi* Walley) were mounted and photographed, figs. 65–76. *Anatopynia nebulosa* Meig. whose plastron Hinton (1968) illustrates, falls in the Macropelopiini. Figures 65–68 show that the plastron of *Coelotanypus, Psectrotanypus, Procladius* and *Conchapelopia* are very similar, and could, without stretching ones' imagination too far, be derived from the type found in *Podonomus*. Considering the affinity between the Tanypodinae and Podonominae shown by other lines of evidence this could be a logical conclusion. The fact that similar patterns of plastron have shown up in groups clearly unrelated to each other and to *Podonomus*—such as

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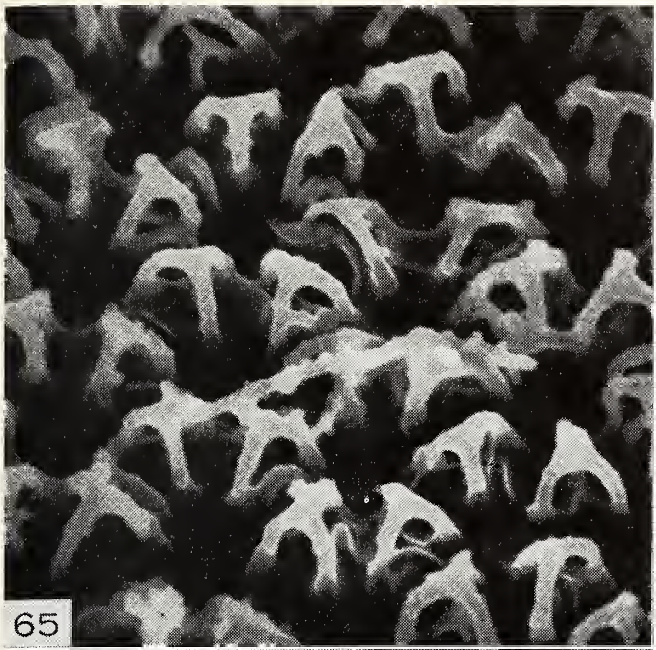
FIGS. 65–70. Details of plastron, electron photomicrographs. Fig. 65—*Clinotanypus pinguis* (Loew) 6,000×. Fig. 66—*Anatopynia dyari* (Coq.) 6,000×. Fig. 67—*Procladius* sp. 6,000×. Fig. 68—*Conchapelopia* sp. 6,000×. Fig. 69—*Ablabesmyia mallochi* (Walley) 6,000×. Fig. 70—*Ablabesmyia mallochi* 10,000×.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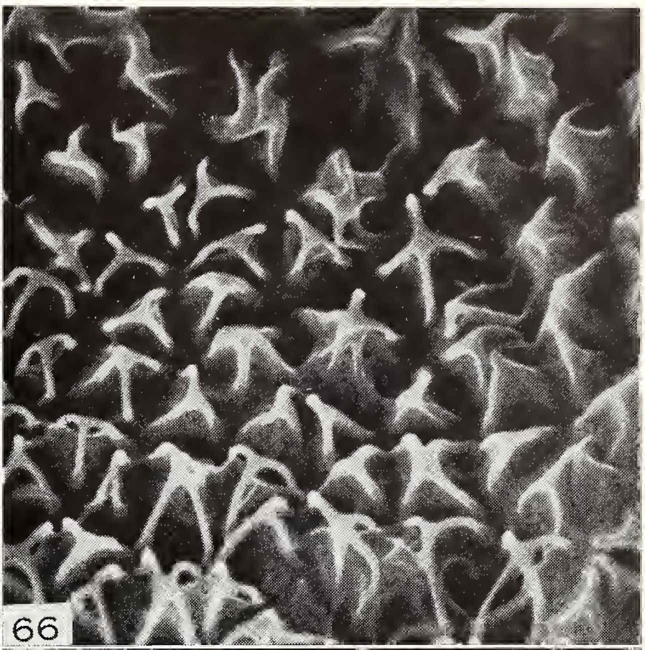
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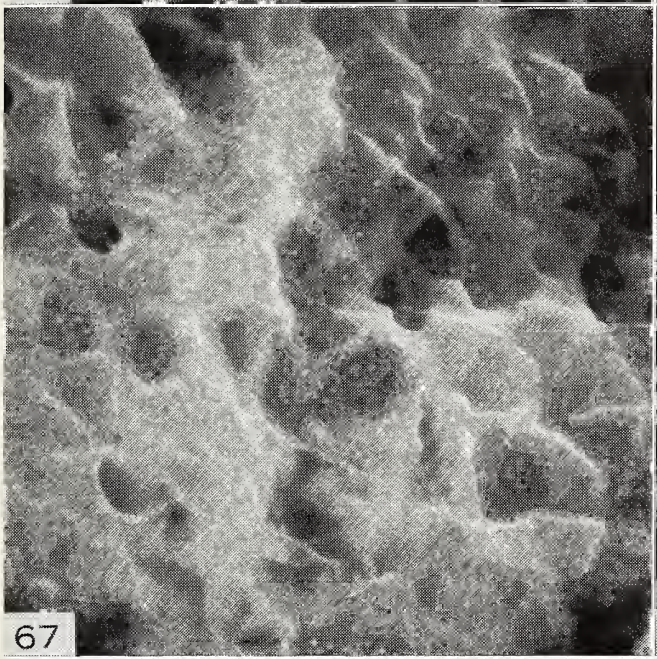
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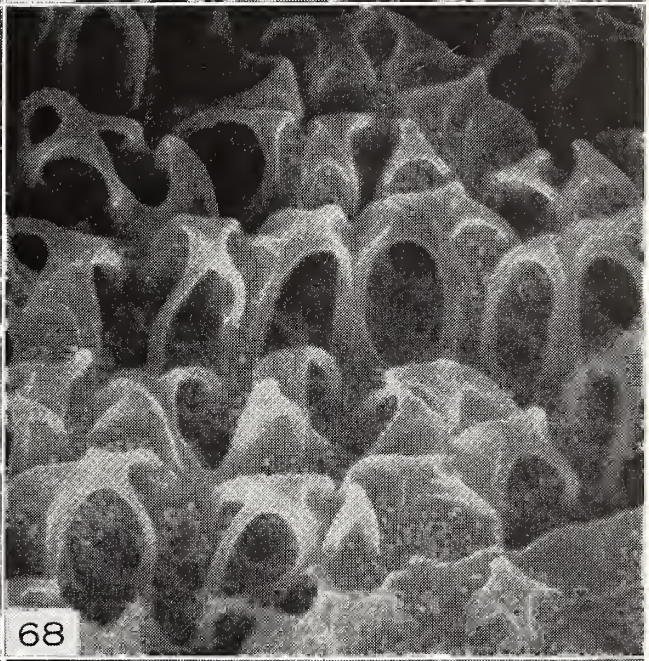
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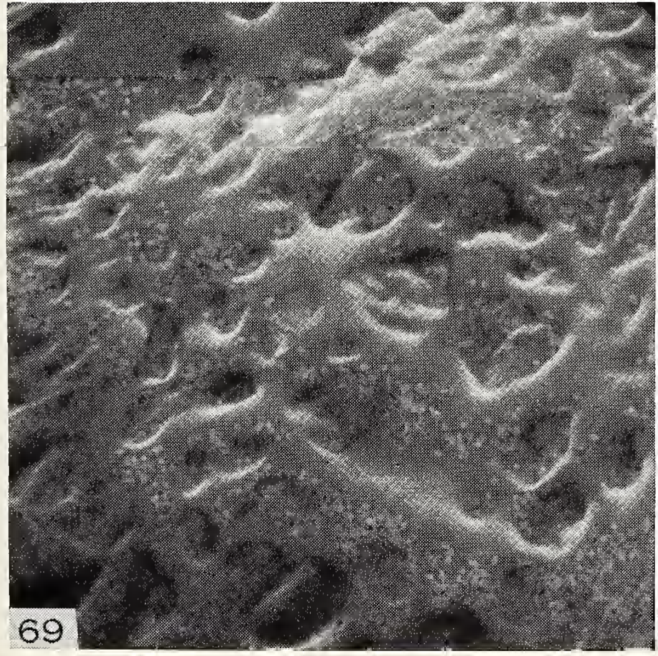
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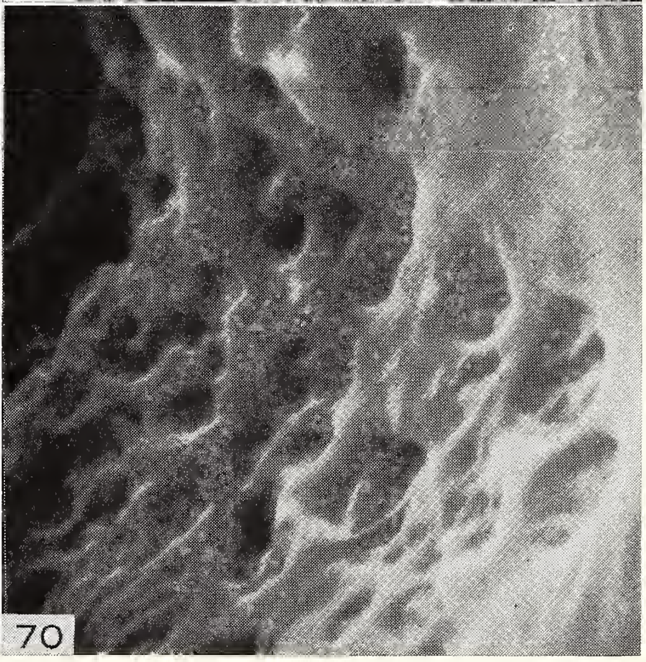
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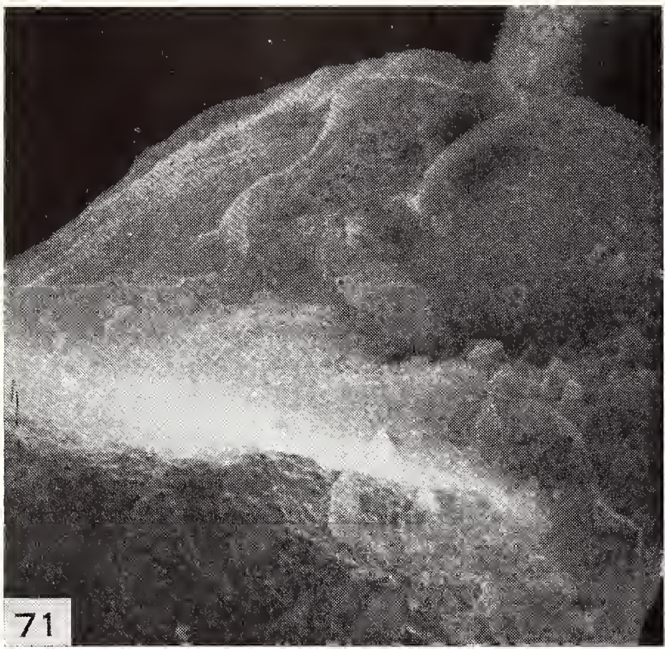
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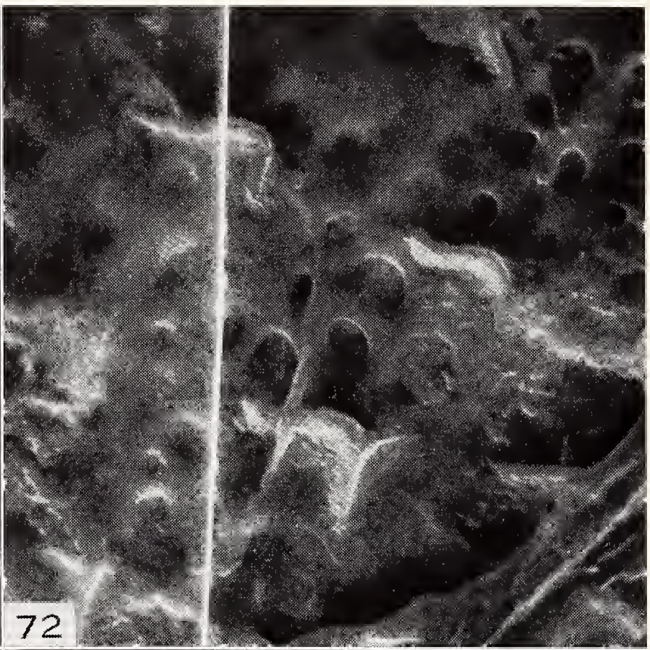
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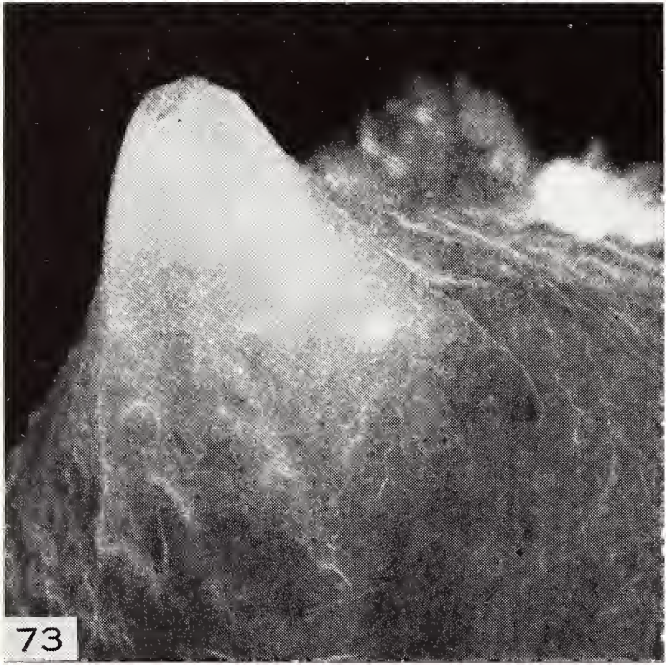
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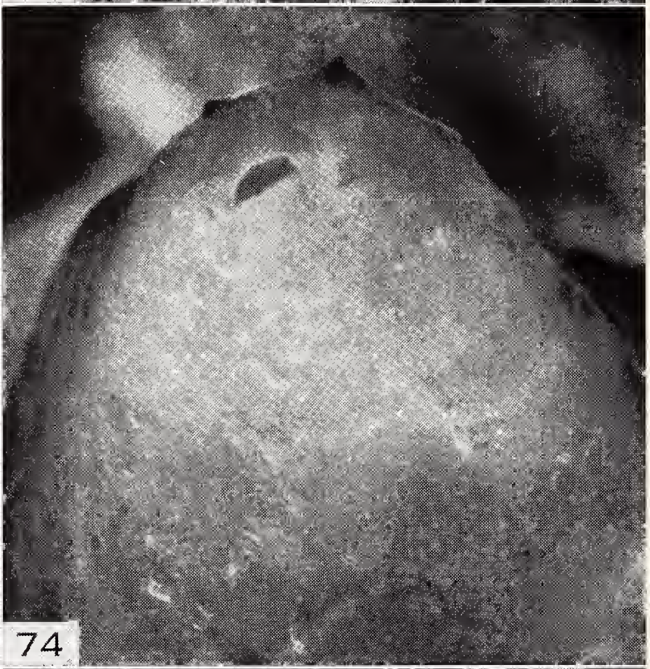
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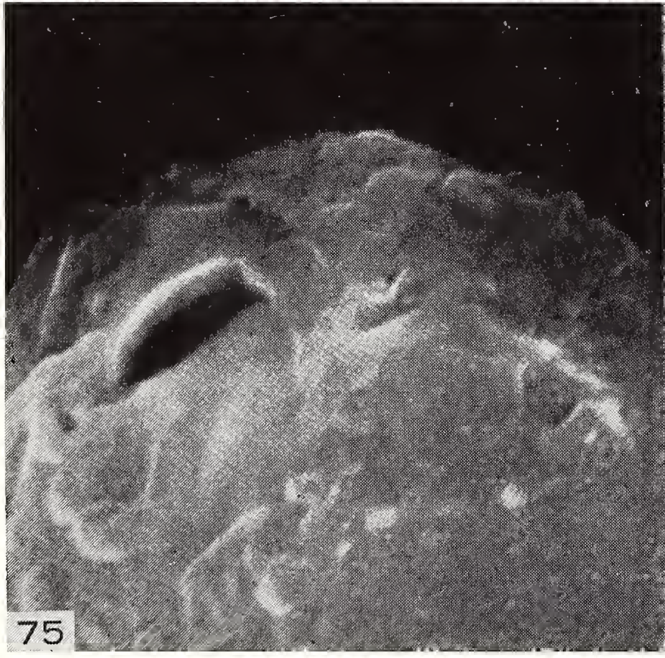
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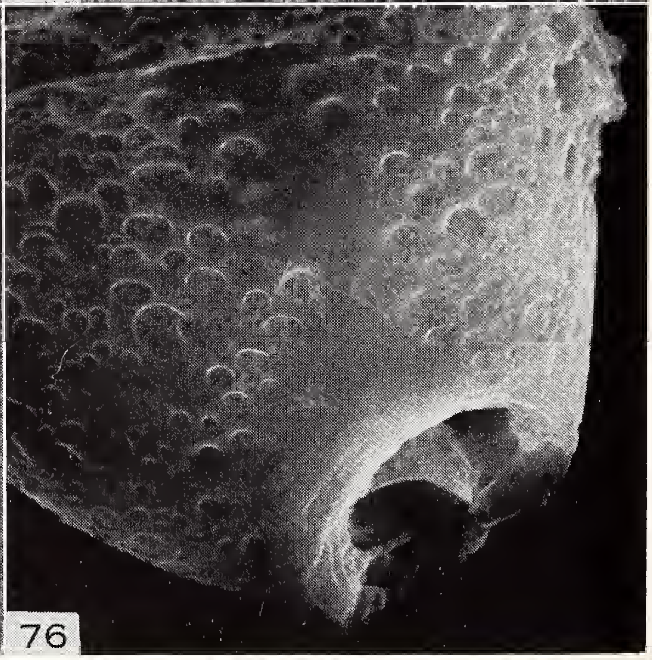
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Geranomyia in the Tipulidae and the egg plastron of *Culex pipiens molestus* (Hinton, 1969)—only indicates that, taken alone, the plastron cannot be used to show relationship but in conjunction with other indications of relationship it provides supporting data. There are, after all, not an infinite number of solutions to the problem of providing an air-water interface for the respiration of aquatic pupae and some basic patterns will repeat themselves.

In *Tanypus* fig. 72–76 and *Ablabesmyia* figs. 69–71 we can see that some genera of the Tanypodinae have evolved different solutions to the above problem. The ovoid respiratory organs of both are covered with a mesh quite different from the other Tanypodinae and most similar to that illustrated by Hinton (1968) for *Pauliana umbra* [Blepharoceridae]. The respiratory organ of *Ablabesmyia* is far less rigid than that of *Tanypus* and fig. 71 shows the collapsed apex with the outline of the aeropyle tube visible. In figs. 73–75 increased magnification of the apex of the *Tanypus* shows what appears to be the aeropyle. Both these genera have only a single aeropyle in each respiratory organ. The white line in figure 72 is an artifact caused by a malfunction of the scanning electron microscope.

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Figs. 71–76. Electron photomicrographs. *Ablabesmyia mallochi* (Walley) Fig. 71—apex of respiratory organ with outline of aeropyle tube, 1,000×. *Tanypus carinatus* Sublette. Fig. 72—plastron 2,500×. Fig. 73—apex of respiratory organ with aeropyle (?) 1,200×. Fig. 74—same, 4,000×. Fig. 75—same 10,000×. Fig. 76—base of respiratory organ, 1,500×.

Male Gypsy Moth Dispersal on Long Island (Lepidoptera: Lymantriidae)

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Abstract: During July 1969, virgin female gypsy moths were used as decoys to sample male gypsy moth populations on Long Island. Although most common near an area in which larvae had completely defoliated tall oaks, male moths dispersed into areas where infestations were sparse or nil. Increases in the average size of male moths were noted at several trapping sites during the sampling period, this change being attributable to the early emergence of small moths in severely defoliated areas.

The gypsy moth, *Porthetria dispar* (L.), was accidently introduced from Europe at Medford, Massachusetts, in 1869. During the century since its establishment, it has spread throughout New England, into Quebec, New York, Pennsylvania, and New Jersey. There is an isolated infestation near Lansing, Michigan and the species has recently invaded both Delaware and Maryland.

The slow spread of the gypsy moth in contrast to the rapid expansion of other European introductions can be explained by the fact that the female gypsy moth is virtually flightless. Long distance colonization, as at Lansing, has presumably resulted from the inadvertent transport of eggs on crates or planting material. However, the more general pattern of new infestation, expanding west and south from New England, can be attributed to larval dispersal. Leonard (1970) has shown how nutritionally determined behavioral modifications in areas densely infested by the gypsy moth result in first-instar larvae spinning down fraom branches on silken threads and being blown away. According to Burgess and Baker (1938), these small larvae may be carried by the wind for 20 miles or more.

Bess, et al (1947) described the forest site conditions most apt to favor the perpetuation of dense populations. These include dry soils, thin humus, and a predominance of oaks. Old, craggy oaks with numerous bark flaps serving as refugia for large larvae, pupae, female moths, and egg masses are especially suitable for the survival of the gypsy moth. Various combinations of favorable conditions are found in many oak-pitch pine areas in Cape Cod, Long Island, New Jersey, and Delaware.

Acknowledgments: I thank Linda McKee, Skee Houghton, and David Horrill for their help in testing the "virgin decoy" technique at several locations in the Town of Brookhaven.

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New York Entomological Society, LXXVIII: 170–174. September, 1970.

During June 1969, larvae of the gypsy moth completely defoliated tall oaks in several favorable areas on Long Island, one near the eastern boundary of the Brookhaven National Laboratory in the oak-pitch pine forest surrounding the Biology Farm. Other defoliation foci in the Town of Brookhaven (Suffolk County) were near the communities of Wading River, Coram, South Haven, and Mastic Beach (Fig. 1).

Near the centers of these heavily defoliated areas, male pupation began as early as June 20, and few female larvae were able to complete their development. In zones where defoliation did not exceed 25 per cent, there was less mortality from starvation and virus wilt disease, and many females pupated during the first two weeks of July.

Taking advantage of these convenient and dense populations of the gypsy moth, I started a preliminary study of adult male dispersal. Such research must be done before the "sterile male release" technique (Proverbs, 1969) is successfully used against the gypsy moth (Godwin et al., 1964; Collier and Downey, 1967). To sample the male moths dispersing from infestation foci, I chose to use decoys, virgin females emitting a pheromone strongly attractive to males (Doane, 1968).

METHODS AND AREAS

Pupal collections from the lightly defoliated margins of the Biology Farm, South Haven, and Mastic Beach infestations on July 7 (and from the first area only on July 22), yielded a supply of freshly emerged, unmated female moths. Usually, five of these virgin moths were placed in a cylindrical cage (15 cm. diameter, 60 cm. long) made of muslin on an aluminum frame. By transporting the caged decoys from one site to another for a series of exposures on the same day, I reduced the effects of intrinsic factors (virgin size and vigor) and extrinsic factors (principally temperature, humidity and wind speed) on trapping success.

The exposure periods were less than an hour at each site, except in situations where few or no males came to the cage during the first hour. Then the cage was left open and male visits estimated from the number of mating pairs found on reinspection or, in extreme cases, from the number of females producing normal egg masses the following day. During most exposures, however, the males were caught and killed in order to avoid counting them more than once and to prevent any from entering the cage. As Doane (1968) indicated, the female gypsy moth, after mating, ceases to attract males, either because its sex lure is masked by a repellant (Beroza, 1967) or because it stops emitting the attractant.

Since it was not always possible to use five virgin females throughout a series of exposures, "decoy minutes" were used to compare trapping success. These were calculated by multiplying the exposure period in minutes by the number of

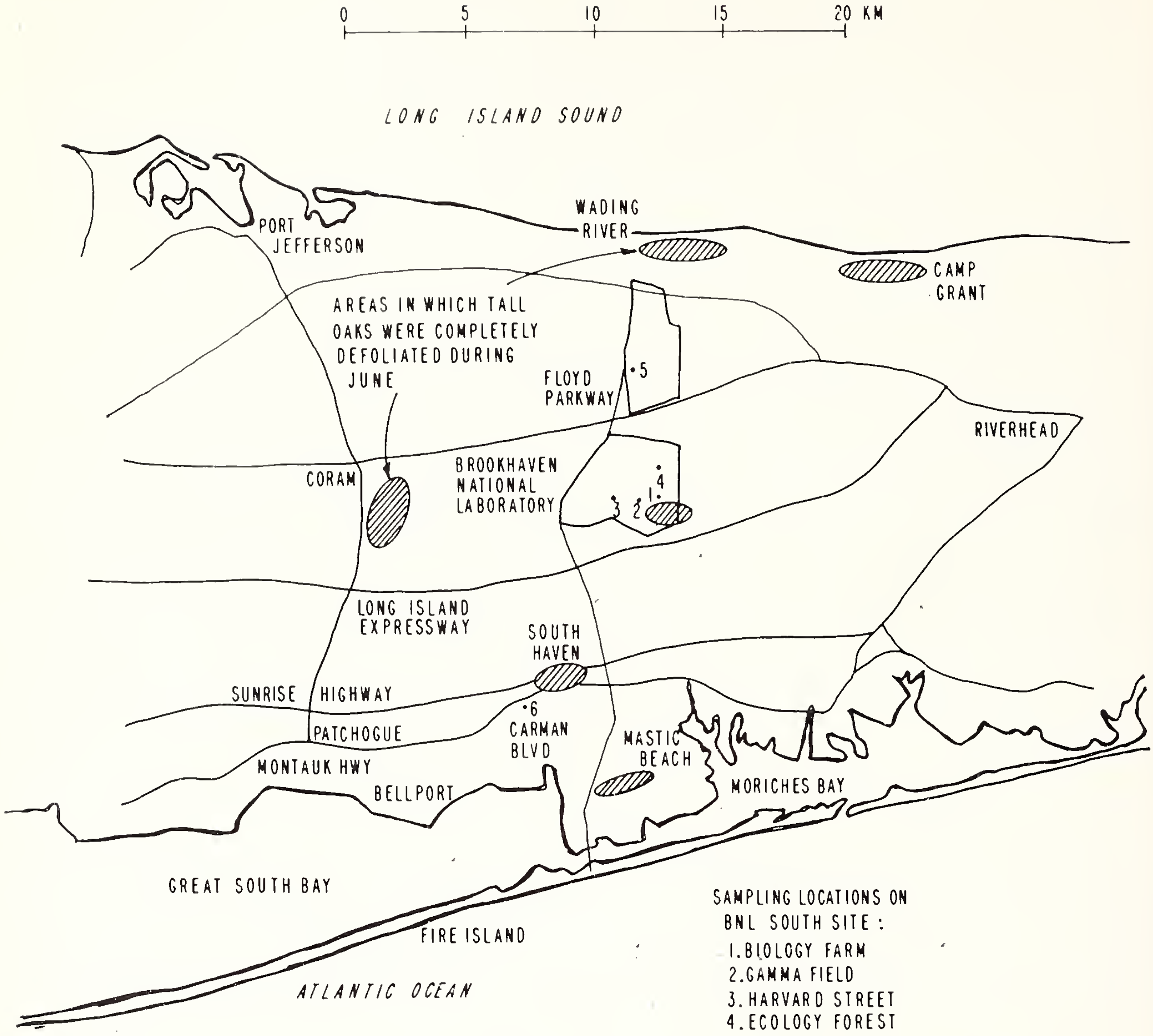

FIG. 1. Gypsy moth infestations and male sampling locations in central Long Island, N. Y., 1969. Hatched ovals designate areas in which tall oak trees were completely defoliated during June. The numbers 1–6 are sampling locations.

unmated decoys. A low number of "decoy minutes" per male caught thus represents a high catch rate and is presumably related to a large number of male moths in the vicinity of the sampling site. However, "decoy minute," like "trap night," is a unit of convenience, and it is likely that five decoys are somewhat less than five times as attractive as one.

Six main sampling locations (Fig. 1) were used, one just north of the Biology Farm infestation and the others near the edges of forest areas with sparse or no apparent infestations. Areas with sparse populations, (probably having less than 25 egg masses per hectare in May or less than 100 larvae per hectare in July), included the Gamma Field, the Ecology Forest, and Carman Boulevard. Neither egg masses or larvae were seen in the Harvard Street or the Floyd Parkway areas. No population density estimates were made at four other locations used for single exposures.

Table 1. Male Gypsy Moth Catch Rates.

Trapping Site	Number of Exposures (July 8–31)	Decoy Minutes per Male Gypsy Moth		
		Minimum	Maximum	Average
Biology Farm	9	0.4	10	3.7
Gamma Field (600 m* west of the farm)	8	1.3	29	9.4
Ecology Forest (1,700 m north of the farm)	11	14	690	175
Harvard Street (2,500 m west of the farm)	13	20	1,175	447
Floyd Parkway	6	9	690	186
Carman Boulevard	14	2.5	110	27
Four other locations in the Town of Brookhaven	4	2.7	282	—

* m = meters

RESULTS

Despite the limitations of this sampling technique, it was quick and simple enough so that over 60 exposures could be made during the period July 8–31. The principal results are presented in Table 1. Male gypsy moths were caught in all areas, even those apparently devoid of larval populations. This indicates that the males are by no means confined to zones where their chances of encountering virgin females are high. At the main tract of the Brookhaven National Laboratory, however, the interval between catches appeared to be correlated with the distance from the Biology Farm infestation, the most remote site, Harvard Street, having the longest intervals.

In a preliminary study such as this one, it would be unwise to use catch rate ratios even for relative estimation of male gypsy moth populations densities, especially since the decoys were least effective near the Biology Farm where they were competing with other virgins. Perhaps it is also premature to attempt a temporal comparison, although catch intervals increased from 0.9 ± 0.4 on July 15 to 5.5 ± 3.3 on July 29 and 31 at the Biology Farm. At Floyd Parkway, the opposite trend was seen, with a decrease from 375 on July 14 to 9.4 ± 5.2 on July 28 and 30. These changes are consistent both with the early emergence of numerous males in the heavily defoliated centers and with the dispersal of males outward from the entire area of gypsy moth infestation. Further evidence in support of this model for moth dispersal was found in the measurements of wing size. The average forewing length (from hinge to tip) increased in several areas (from 16.9 ± 1.6 mm. in early July to 21.1 ± 1.7 mm. in late July at Harvard Street and the Ecology Forest) reflecting the earlier emergence of smaller moths, subjected to malnutrition during their larval stages in the defoliated foci.

DISCUSSION

The wide dispersal of adult male gypsy moths presumably insures the insemination of isolated female gypsy moths, and thus contributes to the spread of the species. Considering the scattering that must occur when first-instar larvae are dispersed by wind, the male exodus from infested areas may well be an evolutionary adaptation.

Whatever its origin, this behavior pattern can hamper the application of sterile male release techniques against the gypsy moth. To eradicate an incipient infestation, it would be necessary to "overflood" the population with enough sterile males to prevent the normal fertilization of any female. Throughout the period during July when females emerge from their pupal shells, sterile males would have to be present in such numbers that no wild male could have a chance to mate. If the sterile males disperse far outside the infestation foci, as wild males do on Long Island, large and frequent releases during July would be needed to prevent the production of viable eggs and the consequent perpetuation of the infestation.

If the release technique is ever tried on a large-scale against the gypsy moth, virgin decoys may play an important role. They need not be used to measure the dispersal of released males since that can be done using traps baited with lures, either synthetic or stabilized natural extracts (Holbrook et al., 1960). However, the virgin decoys would still provide a means for evaluating the ability of the released males to compete with males in the natural population. The decoys can be placed in special containers which prevent their escape but permit male moths to enter (Collier and Downey, 1967). If none of the decoys produce fertile eggs, the sterile release can be considered successful.

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Papilio hyllus Cramer, 1776, vs. *Polyommatus thoe* Guérin-Méneville, 1831, and the "50-year rule"* (Lepidoptera: Lycaenidae)

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Abstract: *Papilio hyllus* Cramer, [1776], is the correct name for the butterfly commonly referred to as *Lycaena thoë* Guerin-Meneville, 1931. This fact was brought to the attention of lepidopterists twice in the 19th century by A. G. Butler and each time ignored by catalogers. In view of the uncertainty about application of the "50-year" rule of I.C.Z.N. no direct action is taken at this time.

In the course of preparing notes for the study of the types of Lycaeninae named by W. H. Edwards, the senior author discovered several references by Edwards to *hyllus* in letters and one in print (B. N. A. vol. 2, p. [310]). It was to settle the problem of these references that he started this study. Discussions during a visit to the U. S. National Museum entomological collections interested the junior author and the two reached the conclusion that the oldest available name for the insect now called *Lycaena thoe* Guérin-Méneville is *hyllus* Cramer.

Until 1860 there was relatively little study of American butterflies by North Americans. Thomas Say and Thaddeus W. Harris had shown some interest but they were more involved with insects that affected agriculture than in taxonomic studies. The decade 1860–1870 saw the appearance of work by four students whose names now are impressed upon the texture of the nomenclature of our butterflies. They were H. H. Behr and Henry Edwards on the west coast and W. H. Edwards and S. H. Scudder on the east coast—a doctor and an actor, a lawyer and a librarian. Behr, a German, was strongly influenced by von Humbolt and Boisduval. If Henry Edwards, an Englishman, was influenced by anyone it was Doubleday. W. H. Edwards was Fabrician in his outlook and Scudder was Hübnerian. Both Behr and Hy Edwards were

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* This study is a by-product of work done on the types of butterflies named by W. H. Edwards under N.S.F. Grant GB 5244.

isolated and depended upon correspondence for help. They had an advantage, good knowledge of the butterflies of Europe, and both had travelled and collected widely in other parts of the world. Scudder was most favorably placed at Harvard University and had its library at his command. W. H. Edwards depended very largely upon periodic visits to the library at the Academy of Natural Sciences in Philadelphia.

The two protagonists on the *hyllus-thoe* argument were W. H. Edwards and Scudder. In this case as in several others Edwards bowed to Scudder who had ready access to the literature and was convinced that *hyllus* Cramer represented a palearctic species. Scudder was deeply involved in many areas of study and his interest in butterflies was secondary, despite the fact that he published extensively and voluminously about them. He made several incorrect pronouncements based upon hasty work or insufficient material. He rarely reversed himself. In the instance of the *hyllus-thoe* problem he was wrong but convinced Edwards and later entomologists that he was right.

USAGE OF HYLLUS AND THOE

Until Butler (1869) published his study of the names used by Fabricius, taxonomists had accepted *hyllus* Cramer as a member of the palearctic fauna. Most of this acceptance was uncritical. Only one student questioned in print the identity of *hyllus*. This was Godart (1823) who suggested that it may refer to a form of *hippothoe* Linne, possibly *chryseis* Borckhausen. We have carefully checked this suggestion by comparing in detail Cramer's figures with specimens of the *hippothoe* complex. The name *hyllus* does not apply to the latter. The females of *hippothoe* lack a reniform spot near the base of cell Cu_2-A on the upper side of the forewing, have one less row of dark spots in the margino-limbal area and the upper side of the forewings usually is well clouded with dark scales. These features clearly separate the figure of *hyllus* Cramer from *hippothoe*-complex.

Specialists who have studied the palearctic butterfly fauna in detail, such as Staudinger and Rebel, and Seitz and his corps of workers, omit mention of the name *hyllus* Cramer. North American specialists have omitted the name from the Nearctic fauna during the 20th century.

Butler (1869, p. 173) in his discussion of *hylla* Fabricius, [1777], did two things. He called attention to *hylla* Fabricius as a variant spelling of *hyllus* Cramer, [1776], and stated that there was in the collection of the British Museum at least one specimen from "Coldwater, near Orilla, Canada West [Ontario]." This statement transferred the name from the palearctic to the nearctic fauna, so far as European specialists are concerned.

Butler corresponded with W. H. Edwards. Either by letter or through Butler's book on Fabrician names, Edwards (1872, p. 33) reached the conclusion that *hyllus* Cramer was synonymous to *thoe* and antedated it. The next year, Scudder (1872, p. 35) erroneously made *hyllus* Cramer the type species of *Chrysophanus* Huebner and (p. 57) considered *thoe* Boisduval to be a synonym of it. Strecker (1874, p. 91) disagreed with this and, apparently considering that *hyllus* hailed from Smyrna as stated by Cramer, made "*hyllus* Edwards (nec Cramer)" a synonym of *thoe* Gray.

Scudder (1876, p. 127) changed his mind, perhaps following Strecker, decided that *hyllus* was Old World and cited as a synonym of *thoe* Boisduval "*Hyllus* Butler (nec Cramer)." Edwards (1877, p. 47), influenced by Strecker and Scudder, backed down on his stand and listed "*Hyllus* Edw. (nec Cramer)" as a synonym of *thoe* Boisduval & LeConte.

In none of these instances is there any evidence produced to support the conclusion that Butler was wrong in 1870. Butler (1899, p. 122) restated his case but this has been ignored by 20th century cataloguers and writers about North American butterflies. The only mention we have found is in Comstock and Huntington (1960, p. 185) wherein *hyllus* Butler (nec Cramer) is cited as a synonym of *thoe* Guérin-Méneville.

OF THE NAMES INVOLVED

Papilio hyllus Cramer

In 1775 Cramer (1:67–68, Pl. 43, figs. B, C.—see our figure 1) figured, described and named *hyllus*, a Copper, from "Smirna." In 1776 (*idem.* index: 153) this name became a binomen: *Papilio hyllus*. The figure clearly represents a female of the American butterfly commonly called the Bronze Copper. The description is adequate but the locality given, Smyrna in Asia Minor, is impossible. In general, citations of the name *hyllus* Cramer by early 19th century lepidopterists refer it to Asia Minor or Smyrna. Since localities cited by 18th century authors must be considered with suspicion, the citation of Smyrna need not restrict the name to the Palearctic region.

Our investigation of the world fauna of Coppers confirms Butler's decision that *hyllus* applies to a Nearctic Copper. The reniform spot in cell Cu_2-A near the origin of Cu_2 on the forewing is absent from almost all Palearctic Coppers and when present is represented by only a few dark scales. (N.B. This character essentially separates *Tharsalea*—with spot—from *Lycaena*—without spot.) Cramer's figure (our figure 1) shows a large, bold spot in this position.

Linnaeus' use of *Papilio hylas* in 1758 does not affect either Cramer's *Papilio hyllus* or Fabricius's modification of the name to *hylla*. We have found no earlier use of *hyllus* (or of *hylus*) than Cramer's.

Opinion 516 of the I. C. Z. N. (1958) established for Cramer's first volume for reasons of priority the ficticious publication date 31 December 1775. This applies to part of the text [pp. 1–132] and plates [1–84] (see I. C. Z. N.

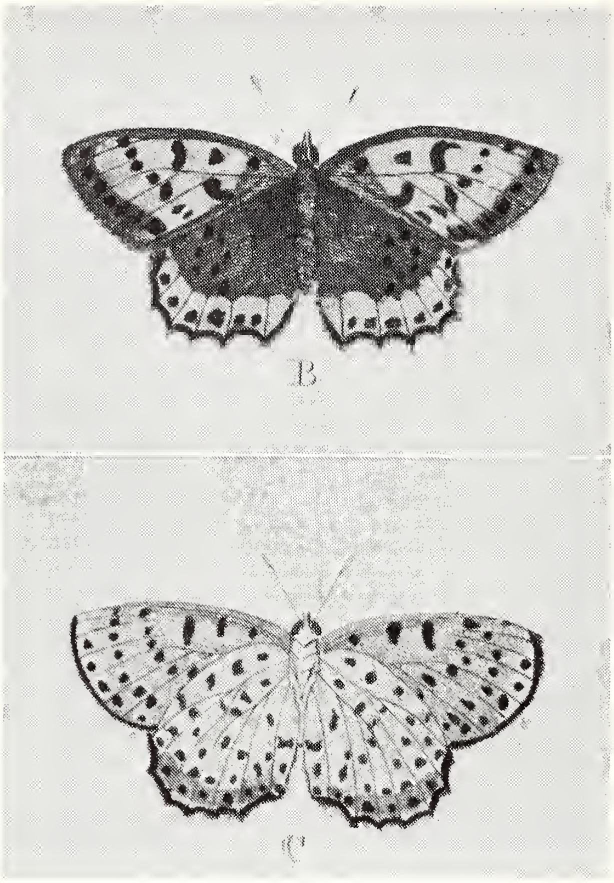
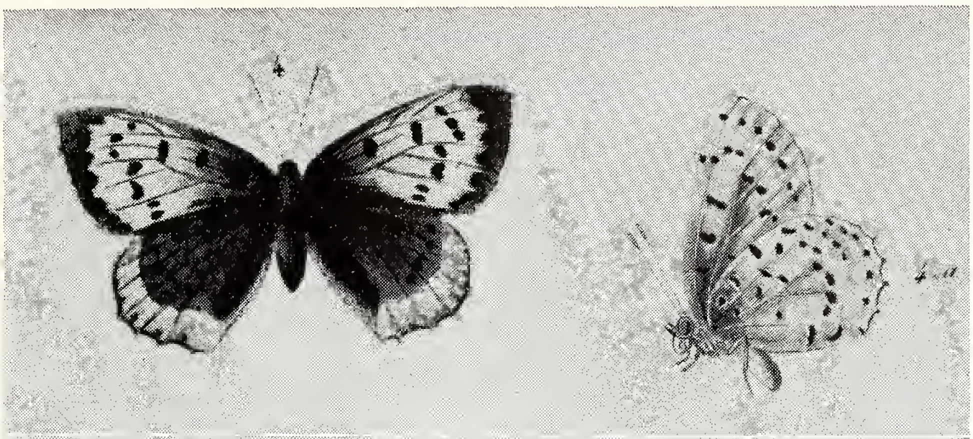


FIG. 1. *Papilio hyllus* Cramer.

Opinion 516, appendix 3, 1958.) However, Cramer did not consistantly use binomial nomenclature in the text nor on the plates. If it were not for the fact that the index to each volume is consistently presented in Linnaean binomials Cramer's names would all be invalid! Therefore the dates for Cramerian names must be the date of publication of the indices. (see Code, Art. 11 (c) and (c) (ii).)

The date for the publication of the index to volume I of Cramer's work is not known. It is treated as though it were published on the last day of 1776—thus [1776]. Since we must date *hyllus* Cramer from the index, this raises the question of priority between that name and *hylla* Fabricius.

Internal evidence from Fabricius's "Genera Insectorum, etc" in which he introduced *hylla* suggests that he had not seen before closing his manuscript all of the plates issued by Cramer in 1775. Therefore his manuscript was closed before *hyllus* Cramer became a valid name through the index. However, the *Prolegomena* to "Genera Insectorum" is dated "Kiliae dit xxvi Decem. 1776." This is the source of the date, 1776, associated with Fabrician names from that work by some authors. We believe that it is unrealistic to assume that the printing and binding of the volume was completed and the volume placed on sale before 1 January 1777. Therefore we use the date [1777] for "Genera Insectorum" making it nominally junior to the index of volume I of Cramer's "Uitlandsche Kapellen . . ." The date [1777] for this work is the one also used by Engelmann (1846:479), Hagen (1862:220), Sherborn (1902:xxiii) and Comstock (1944:593.)



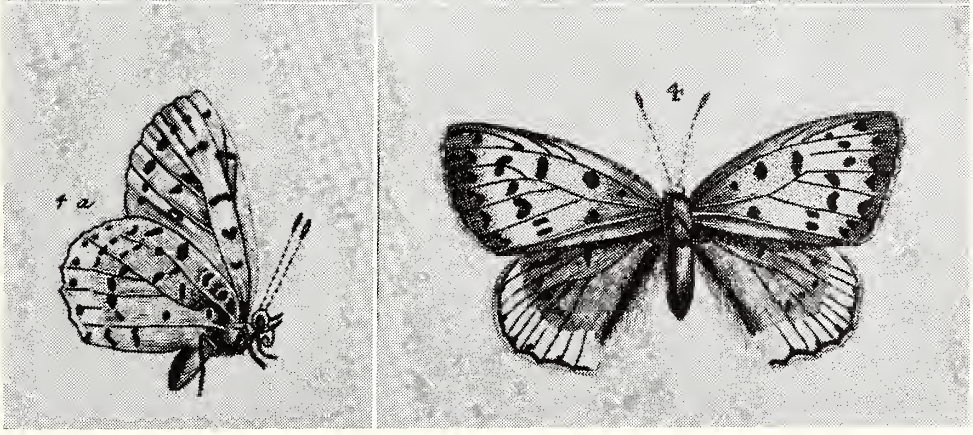


Fig. 2. (upper) *Polyommatus thoe* "Boisduval" after Guérin-Méndeville.

Fig. 3. (lower) *Polyomattus thoe* "Boisduval" after Griffin.

Polyommatus thoe Guérin-Méneville

This name has been plagued with a plethora of authors: Boisduval, Boisduval & LeConte, Gray, Westwood and Guérin-Méneville have been cited as author at one time or another. It first was used as "*Polyommatus thoe* Boisduval" by Guérin-Méneville in 1831 for figures 4, 4a and 4b on plate 81 in his treatment of butterflies in *Iconographie Régne Animal de G. Cuvier* (see our figure 2.) In the text for *thoe* (volume 3, page 490) published in [1844] he credited authorship to Boisduval & LeConte. Meanwhile, Griffith in 1832 published an English edition of the plates for Cuvier's Animal Kingdom. Gray prepared a text to go with the entomological plates. This text has nothing to do with the French text which did not appear until 12 years later. The Plates of the English edition are mirror images of the plates in the French edition and some were slightly retouched. These English plates carry the same names as the French edition for the animals figured but they are in a different style of type, and the plates are differently numbered. *Thoe* appears as figures 4 and 4a on Gray's plate 58 (see our figure 3.)

Authorship for *thoe* must be assigned to Guérin-Méneville, in spite of his acknowledgment to Boisduval. (See I. C. Z. N. Code, Art 50 and Art 51A Recommendation (c).) To be acceptable as author Boisduval must have been responsible for both the name and the conditions of publication. There is no indication that Boisduval was responsible for the conditions under which the name was published. With the date of publication of *thoe* by Boisduval and LeConte now established as [1833] (see dos Passos, 1962) they cannot be considered the authors. Scudder's (1864, p. 163) assignment of *thoe* to Westwood has no rationale.

Papilio hylas Denis & Schiffermuller

Many references to this name for an Austrian "Blue" spell it *hylus*, first used by Fabricius in 1787. We checked original spelling and found it to be *hylas*. The introduction of *hylus* by Fabricius post dates Cramer's *hyllus*. Thus the Fabrician term is a homonym of Cramer's (see Code, Art. 58 (6).) The original spelling, *hylas*, by Denis and Schiffermuller is, as has been pointed out earlier, a homonym of *hylas* Linnaeus 1758.

Incidentally, it appears to us that the majority of names for butterflies proposed in Denis and Schiffermuller are *nomina nuda* and it can be argued that this holds true for *hylas*.

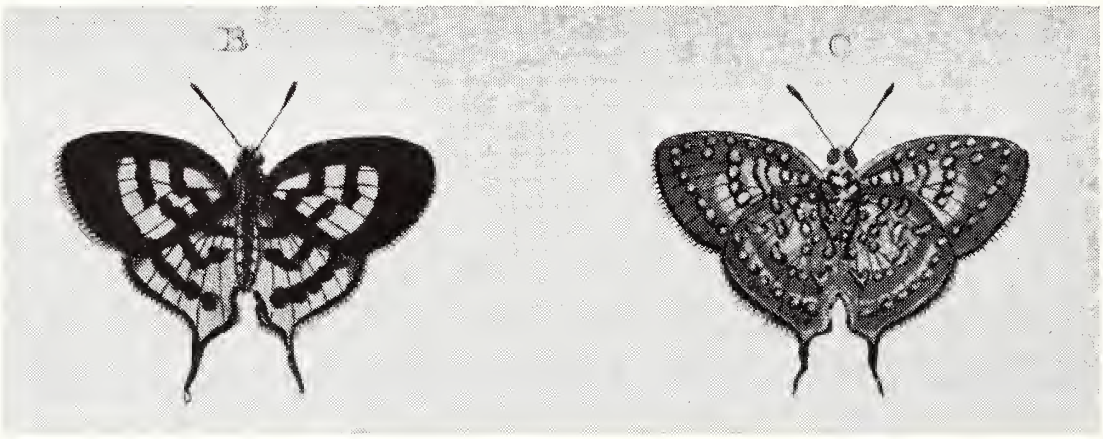


Fig. 4. *Papilio perion* Cramer.

Papilio perion Cramer

When Scudder (1876, p. 127) decided that *hyllus* Cramer was not synonymous with *thoe* Guérin-Méneville and that *hyllus* Butler (nec Cramer) was such a synonym, he suggested that *hyllus* Cramer was a species of *Axiocerses* Huebner. At that time *Axiocerses* (misspelled *Axiocerces* by Scudder) was monotypic with *perion* Cramer its only species. This butterfly is not a Copper but a long-tailed African Hairstreak (?) (see B and C in our figure 4.) Scudder's attempt to associate *hyllus* Cramer with *Axiocerses* and *perion* has no reasonable basis except to hold *hyllus* in the Old World fauna and to remove it from consideration as a Nearctic species.

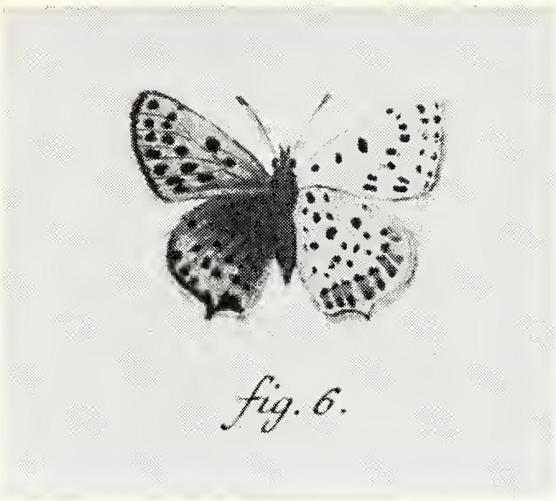


Fig. 5. *Papilio thersamon* Esper.

Papilio thersamon Esper

Staudinger and Rebel (1901, p. 73) in the 3rd edition of their catalogue of palearctic Lepidoptera questioningly suggest that *hyllus* Cramer may be a synonym of *thersamon* Esper 1784. According to them Esper's species is found from southeastern Europe eastward to Turkoman. It is a Copper. Careful comparison of Esper's figure (see "fig. 6" in our figure 5), a female, and also good series of both sexes of *thersamon* with Cramer's figure of *hyllus* prove the two taxa to be amply different. There are many differences but the most easily seen is the absence of the reniform spot in cell Cu_2-A on the forewing on *thersamon* and its presence on *hyllus*. This spot is absent from nearly all palearctic Coppers.

NOMENCLATORIAL CONCLUSIONS

We have reached the conclusion that the combinations *Papilio hyllus* Cramer, [1776], and *Polyommatus thoe* Guérin-Méneville, 1831, are both available for use, and that both represent the same insect. We have proven to our own satisfaction that Butler, (1870, 1899) was correct and that Strecker (1874) and Scudder (1876) and those following their decisions were and are wrong. Thus the proper name for the butterfly commonly called the Bronze Copper in North America is *hyllus* Cramer, [1776].

There is one objection to the adoption of our conclusion. The name *hyllus* Cramer, [1776], has not been used as a senior synonym during the last 50 years. According to the Code of the I. C. Z. N., Art. 23 (b) (i), this makes the name unavailable.

THE 50-YEAR RULE

Article 23 of the I. C. Z. N. Code deals with the "Law of Priority." That law is stated "The valid name of a taxon is the oldest available name applied to it [taking into consideration the provisions of Sections (d) (i) and (e), below], provided that the name is not invalidated by any provision of this Code or has not been suppressed by the Commission." Paragraph (a) concerns itself with conserved names. Paragraph (b) is the "50-year rule." It reads:

> "(b) Limitations.—A name that has remained unused as a senior synonym in the primary zoological literature for more than fifty years is to be considered a forgotten name (nomen oblitum).
>
> "(i) After 1960, a zoologist who discovers such a name is to refer it to the Commission, to be placed on either the appropriate Official Index of Rejected Names, or, if such action better serves the stability and universality of nomenclature, on the appropriate Official List.
>
> "(ii) A nomen oblitum is not to be used unless the Commission so directs.
>
> "(iii) This provision does not preclude application to the Commission for preservation of names, important in applied zoology, of which the period of general usage has been less than fifty years."

There are several points in this section on limitations that need discussion. First, for a name older than 50 years to be available it must have been used as a *senior synonym.* By official definition (Code: Glossary, p. 152–153) the term synonym is applied when "Each of two or more names [are] applied to one and the same taxon." Does this eliminate from use names that represent such unique taxa that no synonyms have been proposed? Todd (1964, p. 66) believes that it does. If so, there are fifty or more names currently used for North American butterflies that are invalid, for example: *Philotes speciosa* (Hy Edwards), 1876, which has no synonyms.

A second point is what constitutes "the primary zoological literature"? This term is not defined by the Commission. Some would argue that only original descriptions are "primary zoological literature" and all other is derived or secondary literature. Until the term "primary zoological literature" is defined there can be no consistent application of section (b).

The statement "for more than fifty years" appears to be definitive, but is it? A name proposed in 1800 but not used in any other publication until after 1850 fulfills this clause no matter how frequently it is used today. Is such a name invalid because during the first fifty years of its life it was not used? For example the Indo-Australian satyrid *Lasiommata lyrnessa* Hewitson, 1872, does not again appear in the literature until Watkins in 1928 made it the type of his genus *Paratisiphone,* 56 years later. Must a new name be proposed for *lyrnessa* because of this?

Since legalistic adherence to the present wording of Article 23 (b) causes absurd situations such as the two we have noted above, we believe that the Article needs reconsideration. We are inclined to favor elimination of section (b). A limited and casual canvas of taxonomists with whom we are working suggests strongly that a majority of them favor such action. Not one likes the section as it stands.

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Effects of Granulosis Virus on Red-Banded Leaf Roller Pupal and Adult Populations[1, 2]

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Received for Publication April 13, 1970

Abstract: Observations were made on several populations of red-banded leaf rollers exposed to high levels of granulosis virus within forty-eight hours after the larvae had hatched. Not only is the adult population decreased in size, but the sex ratios are different from those found in healthy pupal and adult populations.

In general, progressive viral infections of Lepidoptera exist only in larvae and pupae. It is of interest, especially to those investigating the virus as a biological control agent, to observe how such infections contracted in early larval instars may influence subsequent population dynamics.

Tanada and Tanabe (1964) worked with the armyworm (*Pseudaletia unipuncta*, Haworth) and a cytoplasmic polyhedral virus. Mean values of the fecundity and of the life spans of adult armyworms reared from larvae exposed to cytoplasmic polyhedral virus did not differ from larvae unexposed to the virus. The lowest number of eggs laid occurred in matings in which at least one member had been exposed to the virus. However, there were indications in two or three experiments that the infected adults had shorter life spans than uninfected adults. Adult males outlived the females for both the adults from virus-treated larvae and from control larvae.

A considerable decrease of adult life span was also found by Martignoni (1964). In this case a progressive nuclear polyhedral virus infection was experimentally induced in an adult noctuid moth, *Peridroma saucia* (Hübner).

The present study with the red-banded leaf roller *Argyrotaenia velutinana* (Walker) and the granulosis virus *Bergoldia clistorhabdion* demonstrates the effects of a heavy infection, induced in first instar larvae, on the size and sex ratio of the subsequent adult population. Further evidence of disturbances caused by the pathogen in fecundity and the hatching rates of eggs from infected female adults will be presented elsewhere.

MATERIALS AND METHODS

Throughout these studies the red-banded leaf roller colony was reared continually on an artificial medium (E-5) under laboratory conditions as described by Karpel and Hagmann (1968).

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[1] This study was connected with Project no. 12-14-100-8296(33), sponsored by the USDA, Beltsville, Maryland. This paper is part of a thesis submitted by the senior author to the Graduate School of Rutgers University in partial fulfillment of the requirements of the Ph.D. degree in Entomology.

[2] Paper of the Journal Series, New Jersey Agricultural Experiment Station, Rutgers—The State University, New Brunswick, New Jersey 08903.

New York Entomological Society, LXXVIII: 185–189. September, 1970.

Table 1. Composite of Seven Healthy Populations.

Number of Days After Hatching When Pupae Were Collected	Number of Pupae Collected and Percentage Emerging as Adults: Male	Female
24	172 (93%)*	50 (92%)*
25	114 (92%)	58 (88%)
26	126 (95%)	85 (93%)
27	148 (97%)	117 (91%)
28	135 (93%)	121 (94%)
29	126 (92%)	99 (97%)
30	96 (94%)	99 (95%)
31	71 (96%)	109 (98%)
32	61 (100%)	83 (89%)
33	60 (90%)	81 (91%)
34	40 (90%)	50 (96%)
35	23 (91%)	49 (90%)
36	15 (73%)	55 (98%)
37	22 (86%)	31 (94%)
38	15 (80%)	44 (89%)
39	12 (75%)	33 (88%)
40+	9 (78%)	21 (90%)

Overall percent emergence of males: 93.01%
Overall percent emergence of females: 93.16%
Overall percent emergence of total population: 93.08%
Male/female ratio of pupae: 1.05
Male/female ratio of adults: 1.05

* Number of pupae collected on the 24th day includes those which pupated on the 19th through the 24th days, inclusive.

To aid in understanding how an adult population is affected by infection with the granulosis virus during the larval stage, the rates of pupation and subsequent emergence of adults were studied. Three populations (#69, 70 and 87) were infected in the larval stage by spraying the food medium and larvae in the larval rearing boxes with 0.5 mls of a 1×10^8 granules per milliliter concentration of virus within forty-eight hours of the time the larvae hatched.

Seven healthy populations were also used for a composite profile on the normal developmental rates of the healthy insect. From the beginning to the end of the pupation period pupae were removed daily from the larval rearing boxes, counted, washed in 1% sorbic acid in 70% ethanol, and placed in plastic petri dishes. Pupae from populations #69 and 70 were pooled, while pupae from populations #87 and the control populations were separated by sex. As male and female moths eclosed, the dates when they pupated were recorded, and they were removed from their respective petri dishes. In this manner

Table 2. Populations #69 and #70, Infected the Day after Hatching.

Number of Days After Hatching When Pupae Were Collected	Number of Pupae Collected and Percentage Emerging as Adults (Composite of Male and Female)
21	16 (100%)
22	7 (85%)
23	20 (80%)
24	13 (92%)
25	36 (60%)
26	32 (44%)
27	15 (33%)
28	15 (35%)
29	12 (17%)
30	5 (60%)
31	5 (40%)
32	8 (25%)
33	4 (50%)

Overall percent emergence: 59.04%

relative rates of male and female pupation and emergence, as well as the actual number of insects involved, were obtained.

RESULTS AND DISCUSSION

Seven healthy populations were studied and the results pooled to obtain the data listed in Table 1. It is observed that the peak rate of male pupation occurs on approximately the twenty-seventh day after hatching while female pupation reaches its peak approximately a day later and does not fall off as rapidly as does male pupation. Male and female pupal periods were generally of equal duration. However, male moths were usually obtained at least a day earlier than female moths as male larvae pupated earlier than female larvae.

Both males and females have a high rate of emergence as adults with 93.01% of males emerging and 93.16% of females emerging. Thus, 93.08% of all healthy pupae studied successfully emerged as adult moths. While the emergence rates of males pupating late (after 35 days of larval life) decreased significantly, emergence rates for females pupating late did not drop to a comparable degree.

The sex ratio in the healthy populations remained constant throughout pupation and mergence with the male-to-female ratio of pupae being 1.05, and male-to-female ratio of adults also being 1.05.

The two populations, #69 and 70, infected the day after hatching, show that the emergence rates were greatly affected by the presence of the pathogen (Table 2). Emergence fell to an average of 59.04%. It was also observed that larvae which pupated early had a higher emergence rate than did those which pupated later. Those insects pupating on the twenty-sixth day after

TABLE 3. Population #87, Infected the Day of Hatching.

Number of Days After Hatching When Pupae were Collected	Number of Pupae Collected and Percentage Emerging as Adults	
	Male	Female
21	4 (100%)	1 (100%)
22	9 (98%)	2 (100%)
23	22 (91%)	3 (100%)
24	33 (40%)	8 (75%)
25	43 (90%)	13 (100%)
26	36 (67%)	14 (93%)
27	38 (82%)	32 (100%)
28	25 (44%)	12 (100%)
29	25 (44%)	29 (97%)
30	18 (44%)	16 (100%)
31	7 (71%)	10 (90%)
32	12 (25%)	7 (100%)
33	13 (39%)	13 (95%)
34	5 (60%)	4 (100%)
35	5 (20%)	5 (80%)
36	11 (55%)	4 (100%)
37	5 (40%)	3 (100%)
38	6 (50%)	3 (100%)
39	6 (50%)	4 (75%)
40–	11 (45%)	6 (100%)

Overall percent emergence of males: 61.38%
Overall percent emergence of females: 95.24%
Overall percent emergence of total population: 73.61%
Male/female ratio of pupae: 1.77
Male/female ratio of adults: 1.14

hatching had an emergence rate of 44% as compared with larvae pupating on the twenty-first day after hatching with an emergence rate of 100%.

Population #87, infected on the day of hatching, showed differences in mortality rates between the sexes (Table 3). A significant decrease in overall emergence is seen, with 73.61% emergence as compared with 93.08% emergence in the healthy populations. Pupation of infected females reached their peak as in the healthy populations, on the twenty-seventh day after hatching, and males preceded the females by a day or two. However, unlike the healthy males, only 61.38% of the infected male pupae emerged as adults. The female pupae, conversely, had an emergence rate comparable to that of the healthy population (95.24%).

Although infected males had a low emergence rate, they formed a higher ratio of the adult population than did healthy males. Where the healthy population ratio of male-to-female pupae was 1.05, in the infected population the ratio of male-to-female pupae was 1.77. This ratio fell significantly to 0.14 in the adult population. Thus, the sex ratio stability seen in the healthy population was not observed in the infected population.

As in populations #69 and 70, emergence rates for males pupating later than normal tended to decrease. Females maintained a high emergence throughout the entire period.

SUMMARY AND CONCLUSIONS

Observations were made on the rates of pupation and subsequent emergence of several populations of red-banded leaf rollers that had been exposed to high levels of granulosis virus within forty-eight hours after the larvae had hatched. Not only is the adult population decreased in size by infection with the virus, but the sex ratios are also different from those found in normal healthy pupal and adult populations. While the male/female ratio of pupae was 1.05 and of adults was 1.05 in healthy populations, the male/female ratio of pupae was 1.77 and of adults was 1.14 in infected populations.

From the above it is clear that pupation and emergence rates for larvae exposed to high levels of granulosis virus do differ from those seen in normal healthy populations. It is also apparent that males and females are affected differently by the presence of the virus. Males appear to be able to tolerate the virus for a longer period of time than do females, as males succumb in larger numbers as pupae than as larvae. Females appear most susceptible during the larval period, probably because of earlier mobilization of the fat body. The selection pressure of the virus on the red-banded leaf roller population is more severe for the female than for the male.

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Defensive Behavior of a Puerto Rican Cerambycid (Coleoptera)

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Abstract: A beetle, *Chlorida festiva* (Cerambycidae), exhibited defensive behavior including: (1) motionless concealment, (2) stridulation, (3) "attack" with spined elytra, and (4) flight. This escape-attempt series is similar to that exhibited by many other insects, although the predatory pressures leading to its evolution have not yet been identified in this insular situation (Puerto Rico).

OBSERVATIONS

While collecting lepidoptera near Fajardo, Puerto Rico, on 26 January 1970, I observed interesting defensive actions of a cerambycid beetle, *Chlorida festiva* Linn. (Fig. 1). On close approach the beetle remained motionless, and its green body with light tan patches strongly resembled the common background vegetation. When I picked it up, it produced a stridulation, apparently by rubbing the posterior edge of the prothorax against the bases of the elytra. (Other cerambycids sometimes make grating sounds by scraping the hind femora against the elytra). Stridulations can startle would-be predators, and are classified as "warning" sounds. This noise continued to be produced until the beetle spread the elytra, causing the terminal spines thereof to prick my fingers. Although my skin was not pierced, I immediately relaxed my hold, and the beetle took flight. (After brief searching I was able to relocate and collect it).

DISCUSSION

This series of defensive actions is reminiscent of those exhibited by many insects, where concealment or passive behavior is the first line of defense, and where this is followed by a series of active elements such as startle displays or stridulation (Robinson, 1968, Psyche, **75:** 195–207). Perhaps because of the required energy expenditure, flight is often reserved as the last element of an escape-attempt series. The flight reaction also rquires the predator to release its hold, and for this the insect may inflict pain (for example, some cerambycids will deliver a hard bite).

With the impoverished vertebrate fauna of Puerto Rico, it is difficult to predict what animals may have fed on this species before the recent introduction

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Acknowledgment: The specimen was kindly identified by Dr. H. Dietrich of Cornell University, and has been deposited in the collection of the entomology department.

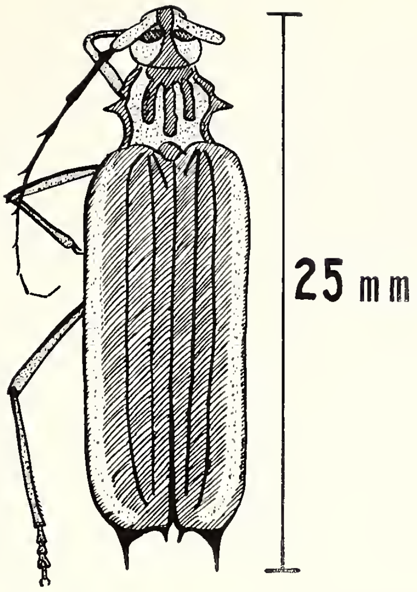

Fig. 1. Sketch of *Chlorida festiva*, showing the short antennal spines, and the long terminal spines of the elytra.

of terrestrial mammals (e.g. rat and mongoose), since it seems too large to be a food item for most species of the resident avifauna, or for invertebrate predators. Even the few local birds which may feed on this beetle (e.g. *Crotophaga ani* and *Ardeola ibis*) appear to have arrived on the Island in recent times. Thus, the complex defensive behavior (or morphological adaptations involved with such behavior) of insects in insular situations, where predators are often few in numbers, presents the question of the identification of the original predatory pressures which enforced the evolution of such defense.

BOOK REVIEWS

A FIELD GUIDE TO THE INSECTS OF AMERICA, NORTH OF MEXICO, by Donald J. Borror and Richard E. White, 1970. 404 pp., more than 1300 illustrations, 16 color plates. Houghton Mifflin Co., Boston. $~~4~~5.95.

This is the latest of the Peterson Field Guide series of natural history manuals. Introductory chapters deal with the necessary preliminaries to work with insects, such as structure, wing venation, growth and metamorphosis and general classification, as well as methods and equipment for collecting and preserving specimens. These are followed by a series of systematic chapters which briefly describe the other groups of Arthropods and take up the insects order by order. A pictorial key in the end pages shows the orders and their diagnostic characters most ingeniously, and a similar one deals with the chief divisions of the Coleoptera. There are very few formal keys. A total of 579 families is given, with the chief characteristics and other information for each. Very small families and those with only very rare species are treated only briefly. The subfamilies of large families are also characterized. Most of the families and subfamilies are represented by pictured examples, and often by figures of the wing venation. Some details about characteristic environments, habits and behavior and, often, economic importance are usually given. Wide use is made of the very valuable "Peterson technique" of indicating by means of arrows on an illustration the most important taxonomic characters. The illustrations are mainly the work of the junior author, who also prepared the section on the Coleoptera. They are most accurately, beautifully and sensitively done.

The enormous numbers and complexity of the insects pose an unequalled problem for authors. To compress even a minimal amount of information necessary for an understanding of the group into a single, relatively small volume, as the authors of this field guide have done, was a task that commands our respect. This book will undoubtedly be very valuable, not only to all persons seriously interested in natural history, but also to a great many entomologists. It must be seen, studied and used to be fully appreciated. The one question in my mind is whether it would not have been better if the authors had been even more selective and had omitted, except, perhaps, by name, the families that almost every amateur and, in fact, most entomologists will almost certainly never encounter. In the space thus gained it would have been possible to give something more like adequate treatment to families of which everybody is sure to encounter many species anywhere. As a lepidopterist I can stand the idea of the Dalceridae (two rare species), Manidiidae (one rare species) and Oinophilidae (one species) going unmentioned; and I would like to see the Noctuidae (over 2700 species) represented proportionately to the Scarabaeidae (nearly 1300 species). However, aside from such intramural differences of opinion, I feel that this Field Guide is a worthy member of the distinguished series in which it takes its place, and that its authors and publishers are very much to be congratulated.

ALEXANDER B. KLOTS
AMERICAN MUSEUM OF NATURAL HISTORY

TAXONOMIST'S GLOSSARY OF GENITALIA IN INSECTS. Edited by S. L. Tuxen. Second edition, revised and enlarged. 1970, Munksgaard, Copenhagen, 359 pp., 248 figs.

The first edition of this book, published in 1956, became an "instant classic" which no serious worker in insect taxonomy could afford to ignore. It was soon exhausted, showing how badly it was needed. In the preparation of the second edition, to which some new authors have contributed, advantage was taken of the opportunity to expand the book greatly, add new illustrations, and cover the most recent literature. In addition to the

NEW YORK ENTOMOLOGICAL SOCIETY, LXXVIII: 192–193. September, 1970.

editor, 27 authorities contributed, covering all orders of insects. Insect taxonomy is greatly concerned with the structures and homologies of the genitalia, which often offer the most reliable, sometimes the only, means of classification. Until the publication of the first edition a considerable amount of chaos prevailed, with many authors failing to consider the work of previous authors, and often coining their own names for structures already named, perhaps several times over. Synonymous terms were proliferating, and causing a great deal of misunderstanding or error. By establishing standards, synonymizing a great many terms, and giving clues to a great many bibliographic references, the first edition noticeably did a great deal to alleviate such troubles, and to help all taxonomists. The second edition will certainly continue this good work on a greatly enhanced scale. Nobody working in insect taxonomy (or morphology) can afford not to use it.

Alexander B. Klots
American Museum of Natural History

SKANDINAVIENS DAGSOMMERFUGLE, by Torben W. Langer, 1970. 147 pp., 218 Photographs. J. Fr. Clausens Forlag, Copenhagen.

This is a small but useful handbook of the Scandinavian butterflies and skippers, which covers all of the 127 species that have been recorded from Denmark, Norway, Sweden, the Faeroe Islands and Greenland. The text is in Danish. All species are illustrated by photographs of specimens, both upper and under sides and both sexes shown where necessary. Characteristics for identification are cited, general distributional data are given, and life history and ecologic information are presented in condensed form. Unfortunately the scientific names of the foodplants are not given, which makes the use of the book difficult for those who do not know the vernacular names. It is interesting to note that of the 127 species 26 occur in North America, only two of these being by human introduction.

Alexander B. Klots
American Museum of Natural History

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Occurrence of Proteases in the Salivary Glands of Cocoa-capsids (Heteroptera: Miridae)

R. KUMAR

DEPARTMENT OF ZOOLOGY, UNIVERSITY OF GHANA, LEGON, GHANA

RECEIVED FOR PUBLICATION JANUARY 26, 1970

Abstract: The presence of proteases has been demonstrated in the salivary glands of 5th instar larvae and the adults of mirid pests of cocoa in West Africa. Their significance is discussed.

The occurrence of proteases has been demonstrated in many insects. They consist of a proteinase of the tryptic type for initial breakdown and peptidase or peptidases for final breakdown of polypeptides into amino-acids.

During a review of literature on the enzymes of cocoa-capsids, the reported absence of any proteolytic enzymes in the salivary secretions (Goodchild, 1952) appeared surprising since at least two species (*Helopeltis* and *Bryocoropsis*) are exclusively pod feeders and salivary proteases have been reported in a number of mirids (Nuorteva, 1954).

MATERIAL AND METHODS

Four species of bryocorine mirids, all pests on cocoa in Ghana, were examined; only field collected material being used. The presence of proteases was detected by the method of Pickford and Dorris (1934). The salivary glands from living bugs were dissected out in distilled water, freed from adhering structures (usually not all tracheae could be removed) and placed in a droplet of buffer solution on the gelatin film of a photographic plate. The latter consisted of a negative plate (22DIN-125 ASA) developed in darkness in 20% sodium thiosulphate solution. The plates were left for 12–24 hours at 22°C in a tank saturated with water vapour to prevent evaporation. A droplet of toluene was added during each test to prevent bacterial activity. Buffer drops were used as controls. The plates were stained with acid fuschin which revealed a clear spot at the site of enzyme action. At least two replicates of the test at each pH were performed. Over 600 tests were conducted.

RESULTS

Helopeltis corbisieri Schmitz, *Bryocoropsis laticollis* Schumacher

The pH values were: 4.0, 4.6, 5.0, 5.6, 6.0, 6.6, 7.2, 7.6, 8.0.

Acknowledgments: The author wishes to thank the International Capsid Research Team, Tafo for the supply of photographic plates and the Director, Cocoa Research Institute for the supply of bugs. The author is grateful to Mr. Dennis Leston for comments on the typescript and for his interest in this project.

NEW YORK ENTOMOLOGICAL SOCIETY, LXXVIII: 198–200. December, 1970.

There was no activity in instars 1–4; the activity was well marked and clear throughout the above range in 5th instar larvae and adults of both sexes. The activity appeared to be slightly greater in the acidic medium.

Sahlbergella singularis Haglund, *Distantiella theobroma* (Distant)

The pH values used were: 4.16, 4.83, 5.0, 5.57, 5.8, 6.0, 6.6, 7.2, 7.6, 8.0. There was no activity in instars 1–4; there was activity in the 5th instar larvae and adults of both sexes at pH values of 6.0, 6.6, 7.2, 7.6, and 8.0. However, in some experiments on 5th instar larvae of *Distantiella*, slight activity at 5.6 pH was noticed. In several plates of 5th instars and adults of both species there was, for unexplained reasons, no activity throughout the above range.

DISCUSSION

The above results show the presence of proteolytic enzymes in the salivary glands of cocoa-capsids and indicate that several different types of proteases are involved. *Helopeltis* and *Bryocoropsis* have two different types, one active in the acid range and the other in the alkaline range. Probably only a single enzyme is present in *Sahlbergella* and *Distantiella* and possibly this is different from those of *Helopeltis* and *Bryocoropsis*. It is noteworthy that the salivary proteases appear only in the fifth instar and in the adults and it would be interesting to relate the occurrence of these enzymes to the distribution patterns of amino-acids in the haemolymph of larval and adult cocoa-capsids.

The absence of proteases in salivary glands of cocoa-capsids reported by Goodchild (1952) may be due to his use of less sensitive methods. The Pickford and Dorris method used above is capable of detecting proteases at 1 part in 6000. Goodchild (1952) however, reports very slight activity when testing for proteinase in the salivary glands.

Distantiella and *Sahlbergella* differ from *Helopeltis* and *Bryocoropsis* in that they may develop without reduction in fecundity, entirely on green vegetative tissues (Gibbs, Picket and Leston, 1968). It is likely, therefore, that the variable results with fifth instars and adults indicated a heterogeneous sampling population. As a corollary to this it is suggested that there is an inductive mechanism at work. This would have adaptive value since bugs feeding on pods switching over to the production of proteases by salivary glands would be able to penetrate the pod and utilize the proteins. No explanation is suggested by the life-histories (Leston, 1970) concerning absence of production of proteases in the first four instars, even in the two species confined to pod feeding. Gibbs and Picket (1966) noted, however, that in *Distantiella,* under all conditions of water stress, later instars confined on seedlings migrated to the upper, leafy part of the stem whereas instars 1 and 2 were able to exploit the lower, woody part. The scoring classes of these authors however, do not indicate if there is a critical point between fourth and fifth instars.

Perhaps it is possible that the production of proteases by 5th instar larvae and adults is associated with the increased need for amino-acids during the later stages of development of gonads in both sexes.

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Undescribed Species of Crane Flies from the Himalaya Mountains (Diptera: Tipulidae), XIX[1]

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Abstract: Five new species of eriopterine crane flies from Uttar Pradesh, Sikkim, and Assam in India and from Thailand are described, these being *Lipsothrix* **orthrotenes**, *Styringomyia* **apiculata**, *S.* **melanaspis**, *S.* **nigrobarbata**, and *S.* **tenuispina**.

Part XVIII of this series of papers was published in the Journal of the New York Entomological Society, **77:** 199–203, 1969. At this time I am describing five further new species belonging to the genera *Lipsothrix* Loew and *Styringomyia* Loew, all from India (Uttar Pradesh, Sikkim, Assam) and Thailand where they were collected by Dr. Fernand Schmid and the late Deed C. Thurman. I express my sincere thanks to the collectors for their interest in these flies.

Lipsothrix **orthotenes**, n.sp.

General coloration of thorax yellow, praescutum light fulvous, posterior sclerites of notum extensively pale brown; legs yellow, femoral tips very narrowly pale brown; wings very pale brown, stigma lacking, male hypopygium with arms of aedeagus very long and slender, nearly straight, virtually as long as the basistyle, bases not expanded.

male: Length about 7.5 mm; wing 7.5 mm; antenna about 3 mm.

Rostrum yellow, palpi black. Antennae relatively long, as shown by the measurements; scape yellow, remainder dark brown; flagellar segments elongate, with dense white setulae. Front light yellow, remainder of head slightly darker yellow.

Pronotal scutum light brown, scutellum and pretergites light yellow. Mesonotal praescutum light fulvous, sides and the humeral region yellow; remainder of notum pale brown, central region of scutum, posterior border of scutellum, and the parascutella light yellow. Pleura and pleurotergite clear light yellow. Halteres with stem pale, knob light brown. Legs with all coxae and trochanters clear light yellow, remainder of legs more obscure yellow, tips of femora narrowly pale brown, of tibiae still more narrow. Wings very pale brown, costal border very slightly darker, stigma not evident; veins pale brown. Longitudinal veins beyond level of midlength of *Rs* with macrotrichia, including also one or two on each Anal vein. Venation: R_{1+2} and R_{2+3} subequal, R_2 less than one-half as long; vein R_4 weakly decurved, terminating before wing tip.

Abdominal tergites light brown, sternites yellow, subterminal segments darker brown to form a weak ring, hypopygium brownish yellow. Male hypopygium generally as in *decurvata* and *malla*, differing evidently in the long slender arms of the aedeagus that are virtually straight throughout, not strongly curved or with expanded bases; arms virtually as long as the basistyle and longer than their basal enlargement.

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[1] Contribution from the Entomological Laboratory, University of Massachusetts.

New York Entomological Society, LXXVIII: 201–205. December, 1970.

holotype: ♂, Hkayam Boum, Manipur, Assam, 8,500 feet, June 23, 1960 (Schmid).

The most similar species are *Lipsothrix decurvata* Alexander and *L. malla* Alexander, which differ in details of venation, coloration of the body and legs, and especially in hypopygial structure, including the shorter curved arms of the aedeagus.

Styringomyia **apiculata**, n.sp.

General coloration of thorax yellow, the dorsum patterned with brown; legs yellow, darkened femoral rings faintly indicated; wings yellow, patterned with brown, including a conspicuous wash in basal half of cell *M*, vein *2nd A* with apex slightly recurved; abdominal tergites light brown, sternites and hypopygium more yellowed; male hypopygium with lobe of basistyle bearing a single seta; dististyle with outer arm long and slender, unarmed, intermediate blade with combs of blackened pegs, inner arm at base with a small acute point.

male: Length about 8–8.5 mm; wing 5.3–5.6 mm.

female: Length about 6.5 mm; wing 6 mm.

Rostrum dark brown, palpi black, bases of outer segments slightly paler. Antennae with scape and pedicel brown, flagellar segments more yellowed, particularly the incisures. Head brownish yellow.

Pronotum obscure yellow, sides dark brown. Mesonotal praescutum obscure yellow, sparsely pruinose, patterned with brown, sublateral stripes broader, intermediate pair narrower, their anterior ends convergent; scutal lobes yellow, brownish black posteriorly and on sides, median area obscure yellow, the color continued posteriorly onto the scutellum, remainder of latter dark brown, postnotum paler brown. Pleura yellow, clearer ventrally. Halteres with stem yellow, knob light brown. Legs with coxae and trochanters yellow; remainder yellow, femora with two vague brown rings, the more basal one broader, midfemur with a concentration of black setae at outer end beneath; tibia with two narrow brown rings, including the apex, tarsi yellow, terminal segment brownish black. Wings yellow, prearcular and costal fields clearer; brown spots at *r–m*, *m–cu* and outer medial fork, veins R_3 and outer half of *2nd A* darkened; a conspicuous paler brown wash in basal half of cell *M*; remaining veins yellow, those beyond cord slightly darker, especially at outer ends. Venation: R_3 suberect, cell *2nd* M_2 narrowly sessile; vein *2nd A* with outer end erect to slightly recurved.

Abdominal tergites light brown, sternites more yellowed, hypopygium brownish yellow. Male hypopygium with outer lobe of basistyle with a single subequal stout seta. Dististyle with outer arm long and slender, outer third slightly more thickened, unarmed, bearing the usual single long terminal seta; intermediate blades each with combs of blackened pegs; inner arm slender, at base farther produced into a rounded plate and a small acutely pointed beak, basal setae unusually few but long. Phallosome including two sets of blackened lobules, none pointed. Ninth tergite semioval, with an apical oval lobule provided with abundant short yellow setae. Ninth sternite narrow, with two nearly contiguous apical setae.

holotype: ♂, Bhairabkunda, Northeast Frontier Agency, Kameng, Assam, 700 feet, March 7, 1961 (Schmid). Allotopotype, ♀, March 6–8, 1961. Paratopotype, ♂, 700–1,000 feet, March 8, 1961.

The closest allies of the present fly are *Styringomyis himalayana* Edwards, *S. mitra* Alexander, and some others, all differing chiefly in coloration of the legs and wings and in hypopygial structure. The small acute point or beak of the dististyle of this species is distinctive and has suggested the specific name.

Styringomyia **melanaspis**, n.sp.

Thorax brownish yellow, restrictedly patterned with darker brown; femora yellow, with two narrow brown rings; wings brownish yellow, prearcular and costal fields clearer yellow, no darkenings excepting a small cloud over *r–m*; abdominal tergites uniformly medium brown, sternites yellowed; male hypopygium with phallosome terminating in a blackened shield-shaped plate.

MALE: Length about 5.5–6 mm; wing 4–4.5 mm.

FEMALE: Length about 6 mm; wing 5 mm.

Rostrum brownish yellow, palpi brown. Antennae with scape darkened, remainder yellow. Head yellowish brown to light brown.

Thorax brownish yellow, mesonotum restrictedly patterned with darker brown, including parallel longitudinal stripes on praescutum on either side of a paler central area, postnotum and pleura more uniformly yellowed. Halteres with stem yellow, knob brown. Legs with all coxae and trochanters light yellow; femora yellow with two narrow brown rings, the subterminal one slightly broader; tibiae with apex and a narrower ring at near midlength brown; basitarsi yellowed, the apices and remainder of tarsi brown. Wings faintly brownish yellow, prearcular and broad costal fields clearer yellow, including the veins, remaining veins more darkened, not including the membrane except slightly at *r–m*. Venation: Cell *2nd* M_2 narrowly to more broadly sessile; vein *2nd A* evenly rounded to margin.

Abdominal tergites uniformly medium brown, sternites yellowed, hypopygium brownish yellow. Male hypopygium generally as in *himalayana*, differing especially in the structure of the phallosome. Outer lobe of basistyle with a single stout seta that is longer than its basal tubercle. Dististyle with outer arm slender, unarmed; intermediate armature of style including two flattened yellow blades, their outer borders with a row of dense short blackened pegs, near base of inner blade with a group of long dark setae. Phallosome distinctive, appearing as a flattened yellow stem that terminates in a massive blackened shield-shaped structure with two protruding spines anteriorly and two more separated smaller points at posterior end, behind the shield with a small blackened point. Ninth tergite a broadly oval yellow plate, the apex very obtuse, terminating in a small central point that is tipped with setae. Ninth sternite narrow, terminating in two strong spinoid setae.

HOLOTYPE: ♂, Saran, Almora, Kumaon, Uttar Pradesh, India, 7,200 feet, September 17, 1958 (Schmid). Allotopotype, ♀, pinned with type. Paratopotypes, ♂♀, with types. Paratypes, ♂♀, Dhur, Almora, 7,400 feet, September 8, 1958; ♂♂, Git Dabling, West Bengal, 5,100 feet, September 15, 1959; ♂♂, Labha, West Bengal, September 11, 1959 (Schmid).

The most similar species is *Styringomyia himalayana* Edwards, which differs in wing coloration, including the more conspicuous darkened pattern, and especially in the hypopygial structure, including the quite different phallosome.

Styringomyia **nigrobarbata**, n.sp.

Thoracic dorsum chiefly brownish yellow, patterned with brown; legs yellow, the darkened areas narrow and not forming complete bands; wings yellow, the restricted but clearly defined brown pattern including areas at *r–m*, *m* and *m–cu*, vein *2nd A* with outer fourth more weakly darkened; abdominal tergites with a pale brown longitudinal stripe, posterior borders of segments narrowly darker brown; male hypopygium with apical lobe of tergite circular; dististyle with inner body compact, the outer smooth blade short and obtuse, blackened pegs very abundant, crowded, darkened setae of lower margin abundant, longer and stouter than in related species; phallosome chiefly yellow, the ends blackened.

MALE: Length about 7 mm; wing 5.5 mm.

FEMALE: Length about 6.5 mm; wing 6 mm.

Rostrum and palpi brown. Antennae with scape brown above, yellowed beneath, pedicel dark brown, flagellum yellow. Head chiefly yellowed.

Pronotum and anterior end of praescutum light brown, remainder of thoracic dorsum yellow to brownish yellow, patterned with brown, pleura yellow. Halteres yellow. Legs with coxae and trochanters yellow; femora yellow, very restrictedly patterned with brown, including two areas on upper surface only, the outer spot subterminal, tibiae yellow, tip narrowly dark brown, fore pair with a vague darkening at near midlength; tarsi yellow, terminal segment blackened. Wings yellow, with a restricted clearly defined brown pattern that includes *r–m*, *m* and *m–cu*; outer fourth of vein *2nd A* more weakly darkened, not including the membrane; veins yellow except in the patterned areas. Venation: Vein R_3 oblique; cell *2nd* M_2 narrowly sessile; vein *2nd A* curved gently to margin, not spurred or recurved, cell *2nd A* broad.

Abdominal tergites yellow with a pale brown longitudinal stripe, posterior broders narrowly darker brown; sternites more uniformly yellowed. Male hypopygium generally as in *himalayensis* and allies, the lobe of basistyle with a single spinoid seta. Dististyle with outer arm long and slender, unarmed, inner body of style a compact mass, the outer blade smooth, short and obtuse, pale brown blackened pegs very abundant, those of margin short and crowded; darkened setae on lower margin of style abundant, black, longer and stouter than in related species. Phallosome chiefly yellow, upper end blackened, produced into very short points, the more ventral pair divergent. Ninth tergite with apex produced into a small circular lobule that is clothed with numerous yellow setae.

HOLOTYPE: ♂, Lathong, Sikkim, 6,560 feet, July 26, 1959 (Schmid). Allotopotype, ♀, pinned with type.

The present fly differs from *Styringomyia himalayana* Edwards, *S.* **melanaspis**, and some others especially in hypopygial structure, including the distinctive dististyle. The unusually abundant blackened setae on this structure has suggested the specific name.

Styringomyia **tenuispina**, n.sp.

Head and thoracic dorsum extensively darkened, the pleura chestnut yellow; femora and tibiae yellow, each with two brown rings; wings yellow, restrictedly patterned with brown, including clouds over *r–m*, *m* and *m–cu*, and the outer third of vein *2nd A* which is strongly recurved at outer end; abdominal tergites yellow, patterned longitudinally with pale brown, posterior borders darker brown; male hypopygium with lobe of basistyle bearing a single spinoid seta; dististyle unusually complex, bearing four separate lobes, the inner two bladelike; phallosome at apex with a long slender curved spine and six small blackened points.

MALE: Length about 6.5–7 mm; wing 4.8–5 mm.

Rostrum and palpi brown. Antennae with scape and pedicel black; flagellum broken. Head dark brown, sparsely pruinose.

Pronotum and anterior half of praescutum dark brown, patterned with black and gray, posterior part of praescutum and central area of scutum yellowed, this extended caudad as a central line on scutellum, mediotergite dark brown. Pleura and pleurotergite chiefly chestnut yellow. Halteres with stem yellowed, apex of knob infuscated. Legs with coxae and trochanters chestnut yellow; femora yellow, with two brown rings, the outer narrow and incomplete, genua narrowly blackened; tibiae yellow, with vague darkenings at near midlength and apex; tarsi yellow, outer segment darkened. Wings yellow, with a restricted brown pattern that includes clouds over *r–m*, *m*, *m–cu* and outer third of vein *2nd A*, with a pale brown wash in cell *M* adjoining vein *Cu;* veins of anterior third of wing yellowed, remaining veins slightly more darkened, especially near margins. Venation: Vein *2nd A* strongly recurved at outer end, without a spur.

Abdominal tergites yellow, each with a conspicuous longitudinal pale brown line, posterior borders narrowly darker brown, these areas producing an almost continuous central line; sternites pale, hypopygium brownish yellow. Male hypopygium with outer lobe of basistyle with a single long spinoid seta, at base the lobe with a small lobe on inner face provided with numerous setae. Dististyle unusually complex, outermost arm long and slender, at near one-third the length with three or four long erect setae, terminating in the usual single long spinoid seta; inner armature including two separate flattened blades that terminate in blackened beaks, the innermost blade with a smaller more basal point and a conspicuous group of unusually long setae, inner blade slightly smaller, its blackened beak shorter and obtuse, outer margin with short dense blackened pegs that appear as a virtually solid line; between the outer arm of style and the inner blades with a fourth extension, longer and narrower than the blades, its inner margin with similar short dense blackened pegs. Phallosome at lower end with four small blackened points and a conspicuous slender curved spine directed dorsad; outer margin of phallosome narrowly blackened, its dorsal end produced into two small black points.

HOLOTYPE: ♂, Chiengmai, Thailand, May 1952 (D. C. Thurman). Paratopotype, ♂, pinned with type.

Styringomyia **tenuispina** resembles *S. javana* Edwards in the wing pattern and venation, differing in the body coloration and especially the very distinct male hypopygium. The specific name was suggested by the slender curved spine of the phallosome.

BOOK REVIEWS

A taxonomic revision of the weevil genus *Dorytomus* in North America. (Coleoptera: Curculionidae). Charles William O'Brien. University of California Press, Berkeley, 1970. 82 pp., 11 pls. $3.00.

This is a well documented revision of the 30 North American species of *Dorytomus*, a genus of weevils which has another 30 or more species in northern Europe and Asia. The author found that many external characters used previously for the determination of species, such as the pubescence, color, size, and punctation, were variable whereas internal characters, such as the genitalia and reproductive organs were more constant. He dissected more than 400 specimens.

In the revision, aids to the identification of these small weevils, (most of which are less than 5 mm. in length) include a general discussion of morphology, a key to the species, comparative notes and degree of variation for each species, and geographic ranges. Helpful also are the line drawings of the genitalia of both sexes, and excellent, enlarged photographs of both lateral and dorsal views. From personal experience of collecting *Dorytomus* in the field and breeding them in the laboratory, Dr. O'Brien has been able to supply some notes on the biology and a list of the host plants which, as far as known, are willow (*Salix*) and cottonwood (*Populus*).

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De Fennoskandiska och Danska Nattflynas Utbredning (Noctuidae). Frithiof Nordström, Svend Kaaber, Magne Opheim and Olavi Sotavalta; ed. Per Douwes. 1969, Lund, Cwk Gleerup. 158 pp., 404 maps (in Swedish).

A very thorough study of the distribution of the Noctuidae in Fennoscandia and Denmark, this is the third in a series on the distribution of the Fennoscandian Macrolepidoptera. The text mentions unusual records and includes short discussions of the distributions. The known records of nearly all of the species are plotted on maps, and a final map shows the chief regions into which the area is divided. A large bibliography is given. For students of European zoogeography this will prove a very valuable work. A few of the species and genera, wide ranging in the Holarctic, occur in North America.

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Post-embryonic Development of *Oppia nitens* (Acarina: Oribatei)

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Abstract: The present research on the life history of *Oppia nitens* C. L. Koch adds another species of oribatoid mite which has been successfully reared under standard laboratory conditions. For the first time culturing was carried through the F_2 generation. For experimentation employing oribatoid mites as test organisms, particularly in regard to the effects of pesticides and herbicides, a standard reference table of their life histories is necessary. A table of published life histories, given herewith, provides the most comprehensive summary of information available.

The laboratory methods followed those of Sengbusch (1954, 1963). A temperature of 20° C. and a relative humidity of 82% were maintained. Adults were isolated from moist mor humus collected from a coniferous forest floor. The average length of time in days for each of the immature stages of the F_1 generation was: egg—8.5; larva—7.4; protonymph—7.6; deutonymph—9.3; tritonymph—12.3. The duration of the combined developmental stages varied from 39 to 55 days. The quiescent period which precedes each molt lasted approximately 2 to 3 days except the one before the exuviation of the adult which continued 4 to 5 days. The average length of time for the post-embryonic development of the F_2 generation was not different from that of the F_1.

INTRODUCTION

The present research on the life history of *Oppia nitens* C. L. Koch represents another species added to the list of Oribatei which have been successfully cultured under standard conditions of temperature and humidity. For the first time a species of oribatoid mite was reared through the F_2 generation.

Oribatoid mites, although once thought to be harmless plant feeders, are now known to be of economic significance. Sellnick (1928) believed that they play an important role in the economy of nature by contributing to the fertility of the forest soil. Woodring (1963) in a discussion of the value of oribatoids to litter reduction stated, "it seems hard to believe that in view of their habits, nutrition, and vast numbers they would not be important." Jacot (1930), on the other hand, pointed out injurious effects induced by their phytophagous habits. However, it was the work of Stunkard (1937) which gave impetus to research on these relatively little-known animals. It was he who established that the oribatoids may act as the intermediate hosts of certain anoplocephaline cestodes.

MATERIALS AND METHODS

The laboratory methods followed those of Sengbusch (1954, 1958, 1963). While they are somewhat tedious, they have produced approximately one-third of the life histories of oribatoid mites which have been reported (Table 3).

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Adults were collected by means of a modified Tullgren funnel (Sengbusch, 1951) from the moist mor humus layer of a coniferous forest floor. They were isolated in separate glass microcells modified from the description given by Jacot (1937) and were observed daily under a binocular dissecting microscope using a magnification of 30×. The microcells consisted of ordinary 3 × 1 inch microslides on which were glued one or two small glass rings. Filter paper was cut to fit snugly in the bottom and moistened to provide the water which is so necessary for this group of mites. A cover was provided by another microslide held in place by a small rubber band. No attempt was made to make this in air-tight seal as these culture cells were then placed in Scheibler desiccators containing a saturated solution of $ZnSO_4$ to provide a relative humidity of 82% (Ludwig and Landsman, 1937). The desiccators were kept in a constant temperature room set at 20° C.

OBSERVATIONS

Like most Acari, the oribatoid mites leave the egg as six-legged larvae and subsequently pass through four molts. After the first molt, they are in the first eight-legged nymphal stage (protonymph), and then pass through two further nymphal stages, the deutonymph and tritonymph.

Each molt is initiated by a quiescent period of various lengths. At its onset the mite fastens its claws (unguiculae) into the filter paper and arches the dorsum. It stays in this position without feeding for two to three days. However, it would be incorrect to refer to this time as a resting period, for internally the mite is undergoing the morphological and physiological changes which will be evidenced in the following stadium. The period is terminated by the splitting of the old exoskeleton (exuvium) and the emergence of the next stage.

All stages nourish themselves in a similar fashion and also carry on the same modes of life. *Protococcus*, a green alga found on bark, was used throughout the investigation as food for the immature and adult *Oppia nitens*.

Ontogeny occurs by a gradual development from the egg to the sexually mature adult. The female mite, attempting to hide the eggs, may insert the long ovipositor into clumps of *Protococcus* or into the crevice between the edge of the filter paper and the glass and extrude the eggs. The eggs are typically oval to ovate and have one side flattened as do many insect eggs. Eggs recently laid have a whitish, almost translucent appearance and are relatively easy to locate in the small culture cells. Within three to four days development becomes evident externally as an amber pigmentation becames visible at both poles. The thin shell is almost transparent and slightly plastic so that major variations in form and color are noticeable with low magnification. A day or two before hatching, the outline of the larva can easily be perceived using a magnification of 60×. Just before emergence, the exoskeleton of the larva becomes totally pigmented with the amber color noted above.

Table 1. Length of time in days of developmental stages of *Oppia nitens* (F_1) at 20° C.

Emergence of larva	Emergence of proto.	Emergence of deuto.	Emergence of trito.	Emergence of adult	Total
9	7	7	8	11	42
10	7	7	9	14	47
10	7	8	5	9	39
7	9	7	13	11	47
8	8	7	18	14	55
8	8	7	11	18	52
11	7	8	7	6	39
6	7	8	9	10	40
8	10	6	6	10	40
6	7	11	7	11	42
10	5	7	9	21	52
Av. 8.5	Av. 7.4	Av. 7.6	Av. 9.3	Av.12.3	Av.45.0

From Table 1 it is evident that there is some variation in the duration of the stadia in this species. From egg to adult 39 to 55 days were required in the eleven specimens that reached maturity. A predominance of the seven and eight days required for the emergence of the protonymph and deutonymph is noticeable. It seems probable that with a large enough sampling and with the environmental conditions approaching optima, the average times would be relatively constant. The greater length of time necessary before the emergence of the adult is due to the greater morphological changes necessary before the final molt.

The F_1 females began oviposition approximately three months after emergence. Because the experiment had to be terminated, only six specimens attained adulthood. From Table 2 agreement can be seen between the total development time in the F_2 generation (46.0 days) and that of the F_1 (45.0 days). No statistical difference exists in the duration of post-embryonic development in the two generations, which supports the prediction that the method of Sengbusch (1954) can be used to culture any oribatoid mite.

We saw no spermatophores in any of the culture cells containing adults. Spermatophores have been described from several species of oribatoids (Seng-

Table 2. Length of time in days of developmental stages of *Oppia nitens* (F_2) at 20° C.

Emergence of larva	Emergence of proto.	Emergence of deuto.	Emergence of trito.	Emergence of adult	Total
8	6	7	10	12	43
9	5	10	13	7	44
9	6	6	11	11	43
7	6	8	4	21	46
7	7	7	8	21	50
9	5	7	11	18	50
Av. 8.2	Av. 5.8	Av. 7.5	Av. 9.5	Av.15.0	Av.46.0

Table 3. Length of time in days of developmental stages of oribatoid mites.

		Emergence of larva	Emergence of protonymph	Emergence of deutonymph	Emergence of tritonymph	Emergence of adult	Total
Hypochthonius rufulus Koch	Sengbusch (1958)	30.0	21.8	19.1	21.5	24.5	122.0
Steganacarus diaphanus Jacot	Hartenstein (1962f)						150
Nanhermannia nana (Nicolet)	Sengbusch (1958)	13.2	20.4	24.1	22.5	31.4	111.3
Hermannia scabra (Koch)	Jalil (1965)	15	16	41	42	70	184
Nothrus silvestris Nicolet	Sengbusch (1958)	15.8	32.9	37.3	28.3	40.0	152.5
Camisia spinifer (Koch)	Sengbusch (1958)	6.7	18.2	26.9	29.1	50.8	125.6
Camisia segnis (Hermann)	Grandjean (1950)						200
Platynothrus peltifer (Koch)	Grandjean (1950)			36			150
Platynothrus peltifer (Koch)	Hartenstein (1962d)		35	27	31	24	117
Platynothrus peltifer (Koch)	Block (1965)						330–360
Trhypochthonius tectorum (Berlese)	Taberly (1952)	11–35	15–20	13–27	15–32	18–50	72–164
Dameus clavipes (Hermann)	Pauly (1956)						75
Dameus clavipes (Hermann)	Sengbusch (1958)	5.1	12.3	12.1	14.5	20.0	64.0
Dameus clavipes (Hermann)	Block (1965)						330–360
Dameus onustus Koch	Pauly (1956)						150
Dameus onustus Koch	Sengbusch (1958)	8.7	28.3	26.7	29.3	40.0	130.3
Dameus onustus Koch	Bhattachyryya (1962)	17.4	58.0	40.0			
Dameus auritus Koch	Pauly (1956)						75
Dameus boreus Bulanova-Zakhvatkina	Sitnikova (1959)	20	19	22	25	30	120
Belba kingi Hartenstein	Hartenstein (1962a)	14±2	15±3	9±2	17±1	9–18	63–76
Metabelba montana (Kulczynski)	Hartenstein (1962b)						65
Cepheus palmicinctum (Nicolet)	Michael (1888)	4	53	40	78	200	375
Eremobelba nervosa Hartenstein	Hartenstein (1962b)	15	10–15	15–18	14–16	11–15	68–75
Ceratoppia bipilis (Hermann)	Michael (1888)						79
Ceratoppia bipilis (Hermann)	Taberly (1957)	3–5	14–24	9–13	9–13	14–31	49–87
Tectocepheus velatus (Michael)	Murphy & Jalil (1964)	13	24	25	28	46	102

Table 3. (*Continued*)

		Emergence of larva	Emergence of protonymph	Emergence of deutonymph	Emergence of tritonymph	Emergence of adult	Total
Oppia nitens Koch	Michael (1888)						40(–)
Oppia nitens Koch	Sengbusch & Sengbusch (1970)	8.5	7.4	7.6	9.3	12.3	45.0
Oppia nova (Oudemans)	Woodring & Cook (1962)						23
Minunthozetes semirufus (Koch)	Sengbusch (1958)	6.1	6.8	7.0	7.1	11.2	38.0
Ceratozetes gracilis (Michael)	Haarløv (1960)						41
Ceratozetes gracilis (Michael)	Hartenstein (1962c)	32	20	36	28	19	119–149
Ceratozetes cisalpinus Berlese	Woodring & Cook (1962)						32
Ceratozetes jeweli Rockett & Woodring	Rockett & Woodring (1966)	12	11	9	9	12	53
Galumna elimatus var. (Koch)	Sengbusch (1954)	14.9	16.1	15.6	15.9	24.8	87.3
Galumna nervosus (Berlese)	Sengbusch (1954)	10.7	8.3	7.9	8.5	11.7	47.1
Galumna nervosus (Berlese)	Sengbusch (1958)	8.8	7.5	7.6	7.3	12.0	43.1
Pergalumna omniphagous Rockett & Woodring	Rockett & Woodring (1966)	11	7	7	7	10	42
Galumna confusa Woodring	Woodring (1965)	7–14	5–8	7–13	11–15	12–17	46–50
Galumna longipluma (Berlese)	Sengbusch (1954)	10.8	10.8	11.5	12.6	15.3	60.9
Acrogalumna longiplumus (Berlese)	Sengbusch (1958)	11.8	13.4	12.9	13.6	17.2	65.8
Galumna parva Woodring	Woodring (1965)	7–8	4–10	7–9	9–11	9–13	33–41
Rostrozetes flavus Woodring	Woodring (1965)	8–9	6–9	8–10	9–13	10–14	35–45
Scheloribates laevigatus (Koch)	Cleat (1952)						42–115 av. 61
Scheloribates laevigatus (Koch)	Woodring & Cook (1962)						64
Scheloribates parabilis Woodring	Woodring (1965)	8–11	3–6	3–7	3–8	3–8	14–24
Scheloribates nudus Woodring	Woodring (1965)	8–11	3–6	3–7	3–7	3–8	28
Protoribates lophotrichus (Berlese)	Hartenstein (1962e)	23	23	27+	32+	23+	150
Euphthiracarus sp.	Rhode (1955)						64

busch, 1961), but there is also evidence that parthenogenesis occurs in some species (Grandjean, 1947; Sengbusch, 1958). *Oppia nitens* probably falls into the latter category.

DISCUSSION

The present research is the first consideration of the life cycle of *Oppia nitens* C. L. Koch since Michael's original work in the late 1800s. Michael reported only the total longevity utilizing crude culturing techniques. The current study lists the duration in days of each immature stage plus the total egg to imago period. These latter figures are more realistic than Michael's because they were obtained under standard laboratory conditions.

For the first time, data are presented from the development of an F_2 generation. Previous workers have generally assumed a lack of distinction between the progeny of parents obtained from nature and the offspring of laboratory raised mites. We were able to demonstrate the similarity of development times between the two groups in this species. Our culturing conditions do not appear to change the duration of the stadia or the total elapsed time for the life-cycle of *Oppia nitens*. Although the earlier assumption was found to be correct, the specific results obtained by experimentation reduce the variables involved in the use of these mites as test organisms.

The forty-nine life histories which have been published, beginning with the initial investigations of Michael in 1884, and continuing to contemporary studies are listed in Table 3. There is wide latitude in the reported times, plus the frequent lack of data for the individual immature stages. A comparison of similar species reveals discrepancies which probably reflect differences in culturing techniques. According to Woodring (1963), ". . . oribatoids have been reared by several . . . but they have been cultured only by Sengbusch (1954), and Woodring and Cook (1962)." For experimentation employing oribatoid mites as test organisms a standard reference table of their life histories is necessary. Table 3 provides the most comprehensive summary of information available.

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Phenology and Distribution of Some *Pterostichus* (Coleoptera: Carabidae) of Eastern Canada

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Abstract: The seasonal occurrence and ecological distribution of five *Pterostichus* species were analyzed by pitfall trapping.

Two species, *melanarius* and *coracinus*, exhibited one activity-abundance cycle per year which extended from May or June to September or October. Reproduction occurred throughout most of this cycle. These species apparently overwinter both in the larval stage and as teneral adults. The remaining species, *pensylvanicus, lucublandus*, and *mutus*, each showed two cycles per year. The first extended from April to July during which reproduction occurred. A period of decreased abundance and activity in midsummer was followed by a second cycle of varying length and intensity between September and November. This was a non-productive cycle composed of progeny of the spring reproductive period. These three species apparently overwinter almost entirely as teneral adults.

P. pensylvanicus was taken mostly in wooded areas, while *lucublandus* occurred almost entirely in non-forested areas. The remaining species were found both in forest and open areas: *coracinus* principally in forest or forest edge, *mutus* also mainly in forest but also in some open areas, and *melanarius* mostly in grassland with some woods. No temporal or sexual difference in distribution was noted.

INTRODUCTION

The initial difficulty encountered in studying many insect populations is the paucity of information of the ecology and life-history of the species.

The genus *Pterostichus* Bon., often referred to as *Feronia* Lat. in Europe, represents one of the largest groups of the family Carabidae with worldwide distribution. Lindroth (1966) described 81 species for Canada alone. The present work reports part of the results of four years study on the phenology and ecological distribution of five of the most common species of eastern Canada: *P. melanarius* Ill., *P. coracinus* Newm., *P. pensylvanicus* Lec., *P. lucublandus* Say, and *P. mutus* Say. All are apparently native to North America except *melanarius* which has been introduced from Europe (Lindroth, 1966). The geographic distribution of *pensylvanicus* and *lucublandus* is almost transamerican; *melanarius* now extends over much of Canada. However, *coracinus* and *mutus* seem to be limited to the eastern half of the country.

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EXPERIMENTAL AREA

The study was done in parts of Gatineau Park, a 35,600 hectare preserve near Ottawa. The area lies between the Gatineau River on the east and the Ottawa River on the west where the land, for much of its length, falls through an escarpment to the river valley. To the south, the elevation decreases gradually toward the Ottawa River.

Geologically, the area is composed of Precambrian metamorphic rock overlaid in places by rocks of Pleistocene and more recent origin. Because of its geologic nature, the area is generally rocky and the soil relatively shallow.

The climate of the study area is different from that of the surrounding valley due to the prevailing west wind in combination with the 150–300 m. elevation of its westward exposure. Average temperature in the area is several degrees lower, both summer and winter, than in the Ottawa valley which averages about 19.3°C. between June and August and –9.8°C. between December and February. Total yearly precipitation is several cm. higher than the average 86 to 87 cm. which falls in the neighboring valley. These conditions lead to considerable accumulation of snow in the study area. Average snow depths recorded in February, 1967 and 1968, were between 47 cm. and 70 cm.

Until the last century, Gatineau Park was almost entirely covered by mixed coniferous and deciduous forest including extensive stands of white pine. These have been virtually destroyed by logging and the area is now covered by deciduous trees. Open areas have been produced by farming, excavations for gravel and recreational development of the land.

Within this general area, 45 pit-traps were set in groups in diverse places for sampling the substrate invertebrates in a variety of abiotic conditions and community types varying in elevation from 83 m. to 395 m. above sea level. Summary descriptions of these places, on a macrobiotopic level, are given below.

SERIES 1:

(a) Traps 1–3. Open area covered by dense grass between an extensive stretch of closely mowed grass and mixed woods. Milkweed (*Asclepias syriaca* L.) numerous with some goldenrod (*Solidago* ssp.) and blue vetch (*Vicia cracca* L.).

(b) Traps 4–6. Mixed woods consisting of maple (*Acer saccharum* Marsh), basswood (*Tilia americana* L.) and elm (*Ulmus americana* L.). Understory composed of vetch, aster (*Aster* sp.), thistle (*Cirsium* sp.), and juniper (*Juniperus communis* L.). Some cedar (*Thuja occidentalis* L.)

SERIES 2: Traps 7–9. Forest mostly of maple and a few birch (*Betula* sp.). Substrate rocky under thin litter.

SERIES 3:

(a) Traps 10–11. Area dominated by juniper with a few sumach (*Rhus typhina* L.)

(b) Trap 12. Wet area between juniper barren and mixed conifer wood. Willow (*Salix* ssp.) and goldenrod dominant.

SERIES 4: Traps 13–15. Open transition area.

One trap (13) shaded by sumac and surrounded by grass and bracken (*Pteridium aquilinium* (L.)). Two traps unshaded; milkweed dominant emerging from grass and bracken.

SERIES 5: Traps 16–18. Open area created by old gravel excavation; earlier successional stage than Series 4; ground stony; little humus. Cover changes drastically during the year and consists of goldenrod, blue weed (*Echium vulgare* L.) white clover (*Melilotus alba* Desr.) and raspberry (*Rubus* sp.).

SERIES 6:

(a) Traps 19, 19A. Ten meters inside a moist woods consisting mostly of poplar (*Populus tremuloides* Michx.) and ash (*Fraxinus* sp.) (19A). Trap 19 just outside former woods at the edge of an extensive gravel pit which still is used occasionally.

(b) Traps 20–21. In a gravel pit; barren, rocky ground with a few sumac and some strawberry (*Fragaria virginiana* Duchesne).

(c) Trap 22. On an open sandy rise, not recently disturbed; strawberry numerous; also St. John's wort (*Hypericum perforatum* L.) and goldenrod.

SERIES 7: Traps 23–25. Open area completely surrounded by woods and covered by grass with aster, goldenrod, and timothy (*Phleum pratense* L.) abundant. Trap 23 at edge of woods.

SERIES 8: Traps 26–28. High wooded hill (395 m. above sea level); traps 26 and 27 on the western exposure of the hill; ground covered mostly by *Carex* sp.; trees consisting of stunted maple, ash, and oak (*Quercus* sp.). Trap 28, 20 m. from exposed western edge; trees taller including oak, maple, ironwood (*Ostroya virginiana* (Mill.)).

SERIES 9: Traps 29–31. At the foot of the former hill under mature maple and beech (*Fagus grandifolia* Ehrh.) with numerous maple saplings.

SERIES 10: Traps 32–34. In a damp woods dominated by paper birch (*Betula papyrifera* Marsh) and some maple saplings.

SERIES 11: Open area, partly cultivated.

(a) Traps 35–37. One trap (35) in a grassy clearing surrounded by willow; goldenrod very numerous in summer (100+ plants per m^2) reaching a height of 1–2 m. Trap 36, in damp ground among and shaded by willows, 2–3 m. tall. Trap 37, two meters from a hay field; damp ground completely covered by sensitive fern (*Onoclea sensibilis* L.).

(b) Traps 38–41. Cultivated hay field consisting mostly of timothy and including a few scattered milkweed and vetch; hay mowed once per year in August. Trap 41, just outside hay field in recently uncultivated ground surrounded by juniper, apple (*Malus* sp.) and small elm; low grass cover.

SERIES 12: Traps 42–44. A stand of mature white pine (*Pinus strobus* L.), 20–30 m. tall; undergrowth of numerous maple saplings; litter mainly pine needles; soil relatively dry.

CENSUS METHOD

Populations were studied by pit-trapping, using modified plastic flower pots as traps. Each trap was 20.3 cm. in diameter at the top rim and 19.7 cm. deep. Three holes in the bottom of each trap covered with small mesh plastic screen served for drainage. A wire screen platform on metal legs was placed in the bottom of each trap. The screen mesh was large enough to allow insects to fall through to the bottom of the trap but small enough to exclude possible predators such as mice and shrews. To prevent insects escaping from the trap, a ring of commercial heat-stable silicon grease was placed around the inside wall a few centimeters below the top rim. Preliminary experiments showed that this presented an effective barrier to most insects except those with very long legs, such as Opilionidae and jumping insects which might escape without encountering the grease. A rain-shield consisting of a transparent plexiglass disc, about 23 cm. in diameter, elevated on metal legs several cm. above the ground was placed over the top of each trap.

Traps were emptied once each week. The catch was preserved in 70% alcohol with a small amount of glycerine added to keep specimens pliable for subsequent dissection.

Reproductive condition was determined by dissecting females and examining the ovaries. In 1968, the number of mature eggs in the oviducts was also counted. The elytra and wings were displaced laterally and the thin, dorsal body wall cut around the edges and folded back to reveal the ovaries. These lie ventral to the digestive tract but are usually easily visible when the intestine is slightly displaced laterally. Three reproductive categories were recognized: (1) mature females containing mature ova in the oviducts, (2) teneral females without mature ova, (3) spent females without mature ova. The latter two categories can be distinguished by the presence or absence of a so-called "corpus luteum" in the pedicel of the ovariole. In these beetles, the ovarioles are of the polytrophic type in which the eggs alternate with nutritive cells. The "corpus luteum" consists of the yellowish brown remnant of these trophic cells which accompanied the egg during its descent from the ovariole and which remains behind when the mature egg enters the oviduct. In females which have oviposited previously, the "corpora lutea" are usually clearly visible under low power magnification, as an interrupted dark band across the base of each ovary. The

Table 1. Total number of *Pterostichus* trapped, 1966–1969. Figures in parentheses are estimated numbers for 1966 if trapping had begun before May 30, 1966.

Species	Year 1966	1967	1968	1969
P. melanarius	582	342	300	345
P. coracinus	110 (111)	93	91	110
P. lucublandus	262 (301)	217	259	299
P. pensylvanicus	143 (194)	167	346	352
P. mutus	47 (62)	37	40	57

lateral oviducts of spent females are also much broader and more flaccid than those of teneral females.

An index of sexual activity was obtained for the 1968 catch by examining the spermathecae of females for presence of sperms. Spermathecae were extracted and placed successively in absolute alcohol and acetone for several minutes then washed in xylene and mounted on slides in permanent mounting medium.

In four of the five species, the spermatheca is an obvious, more or less finger-shaped structure lying ventral to the digestive tract in the posterior part of the abdomen. It can be readily located by displacing the posterior part of the hind gut dorsally. With the specimen emersed in alcohol, the spermatheca and its duct and the spermathecal gland and duct usually protrude dorso-laterally, and always on the right side, from the base of the vagina near where the latter connects to the median oviduct. There is considerable variation between different species, however, in shape of the spermatheca and in length and point of connection of the spermathecal and glandular ducts. In *P. lucublandus*, the spermatheca is particularly difficult to locate as it is closely apposed to, and curling around, the base of the vagina.

PHENOLOGY

The total number of individuals of each species trapped during four consecutive years is shown in Table 1. Trapping in 1966 began May 30 by which date at least three of the species had been active for some time. The numbers in parentheses in Table 1 represent the approximate numbers which might have been obtained if trapping had included the total active period of each species. The upward adjustment represents the average percent of each species trapped before May 30 in other years.

Populations of all species decreased to varying extents from 1966 to 1967. Based on the adjusted catch for 1966, *melanarius* decreased by 41%, *mutus* 40%, *lucublandus* 28%, *coracinus* 16%, and *pensylvanicus* 14%. This decline could have been due to the cold winter and spring of 1966–67 but it could also be ascribed to a trapping artifact which will be discussed later. Except among *melanarius*, numbers caught had returned by 1969 almost to the estimated 1966

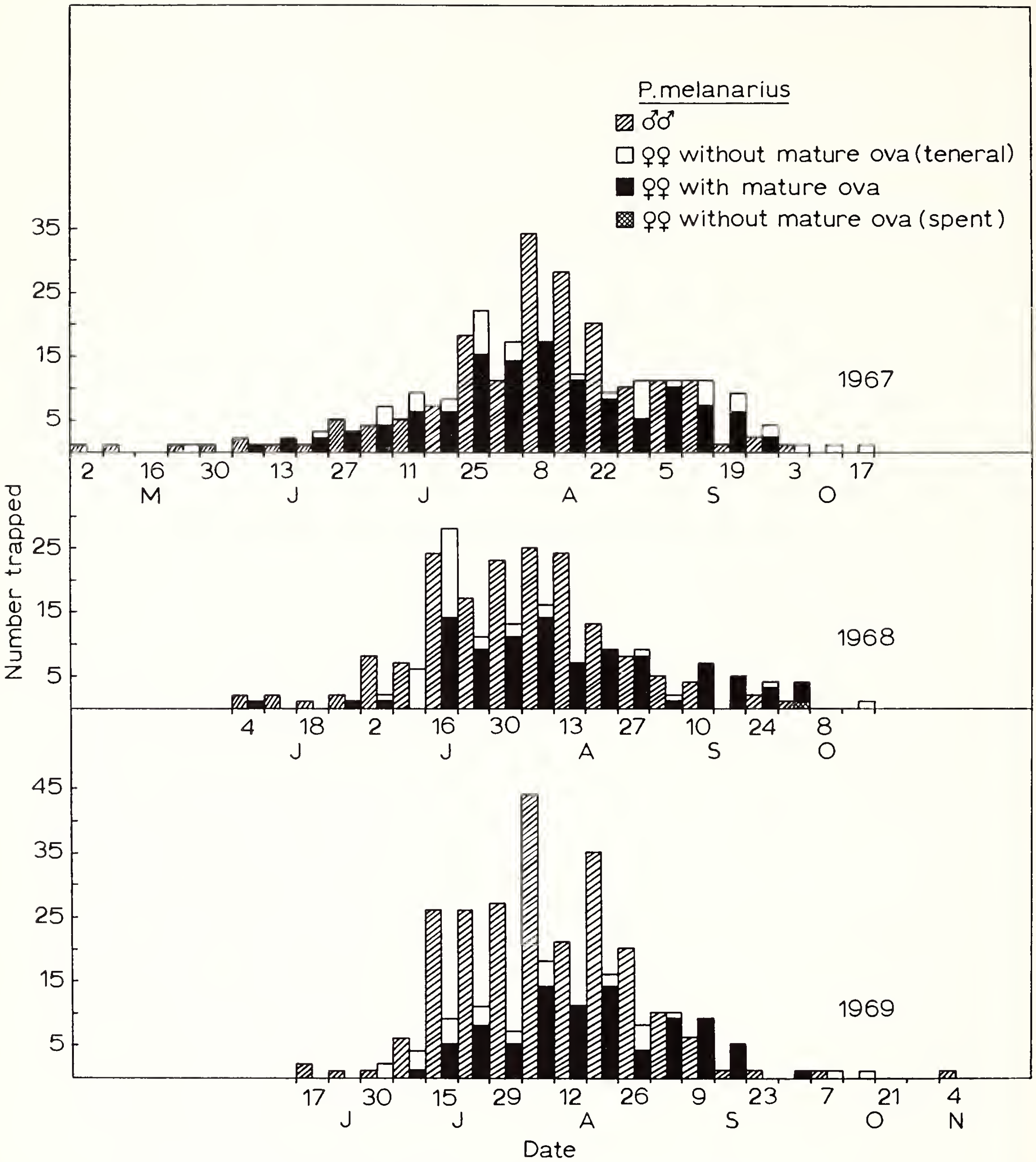

FIG. 1. Number of adult *P. melanarius* trapped per week, 1967–1969.

catch. Only *pensylvanicus* had increased beyond the 1966 level; the 1969 catch was about double that in 1966.

Figs. 1–5 show the number of adults of each species trapped per week during 1967 to 1969 inclusive and the reproductive condition of the females. The 1967 population was not examined for the presence of spent females. Data for 1966 are not included because they are incomplete for some species before May 30. Numbers are from the week ending with the given date and reflect both the absolute number of individuals in the population and the activity of those in-

Table 2. Number of teneral females as percentage of total females trapped during 1968.

		Species			
Date	*P. melanarius*	*P. coracinus*	*P. lucublandus*	*P. pensylvanicus*	*P. mutus*
April 9	–	–	–	50	–
16	–	–	–	75	0
23	–	–	80	29	0
30	–	–	33	25	–
May 7	–	–	10	0	–
14	–	–	13	0	0
21	–	–	0	0	0
28	–	–	0	0	–
June 4	0	–	0	0	0
11	–	–	0	25	0
18	–	0	10	25	33
25	0	0	0	14	–
July 2	50	0	0	0	–
9	100	100	25	16	–
16	50	50	40	100	–
23	20	25	50	–	–
30	15	50	100	–	–
Aug. 6	13	0	100	–	–
13	0	0	–	–	–
20	0	–	–	–	–
27	11	66	0	0	–
Sept. 3	50	0	0	0	–
10	0	0	0	–	–
17	0	–	0	0	–
24	25	–	0	0	0
Oct. 1	0	–	0	0	0
8	–	–	–	0	–
15	100	–	0	0	–

dividuals. Larvae of these species are mostly subterranean and therefore not caught by pit-trapping.

P. melanarius

Adults of this species had one activity-abundance cycle per year which typically began late in May and ended in October (Fig. 1). These dates were somewhat variable but the greatest numbers occurred through July and August. Peak numbers were realized about three weeks earlier in 1968 than in the other two years. This reflects the influence of temperature on rate of maturation and activity of members of the population. Weekly mean temperatures, from hourly readings recorded at ground level between March 1 and April 16, were consistently 1° to 9° higher in 1968.

This species is a summer-autumn breeder. Approximately the same phenological pattern was evident in the population each year. Gravid females were present throughout the whole activity cycle but the proportion of gravid to teneral females varied during the cycle. The species overwinters as larvae as recorded by Greenslade (1965) although some adults may also overwinter. The few gravid females trapped in June most years may have overwintered as adults. In early July, a proportion of teneral females with small, immature ovaries occurred in the population (Table 2). These were probably derived from individuals which had overwintered as larvae. This proportion later decreased and most females trapped subsequently were gravid. This suggests that most progeny from this generation do not mature but overwinter as larvae because it is unlikely that progeny produced after August would have time to mature before development was halted by cold. However, some teneral females always occurred toward the end of the cycle. These individuals usually had large fat-bodies which may be a preparation for hibernation. Sperm was present in the spermathecae of all three females which occurred at this time in 1968 but the ovaries were immature. There may be a reproductive diapause in a proportion of the population. Greenslade (1965) claimed that some adults of this species may hibernate and breed in a second season.

Some spent females also survive in the population, for a time at least, as evidenced by the one trapped on October 1, 1968. Whether or not they survive the winter and breed the following year as Greenslade (1965) claimed and as is the case with other species (Penney, 1965; Vlijm, 1968) is speculative but there may be more of these females in the population than this one specimen would indicate. Vlijm (1968) noted that locomotor activity of spent *Calathus* females is severely reduced which decreases the frequency with which they are trapped.

P. coracinus

This species also had one activity cycle per year which was essentially similar to *melanarius* and extended from late May or early June until September or October (Fig. 2). Peak numbers usually occurred somewhat earlier than *melanarius*. Initiation of the cycle seems to be influenced by temperature since it began three weeks earlier in spring, 1968, when temperatures were consistently higher than in the other two years. Males occurred two to five weeks earlier than females and were more numerous, particularly early in the cycle.

Reproductively, this species also resembles *melanarius*. It is a summer-autumn breeder, gravid females occurring throughout the active period. The proportion of teneral to total females in the population at different times in 1968 (Table 2) indicates that many individuals overwinter as larvae. Young produced by the gravid females which occurred late in the activity cycle could not have matured before winter and must have overwintered as larvae. Some tenerals did occur late in the cycle however, particularly in 1967, 1969, and during the week

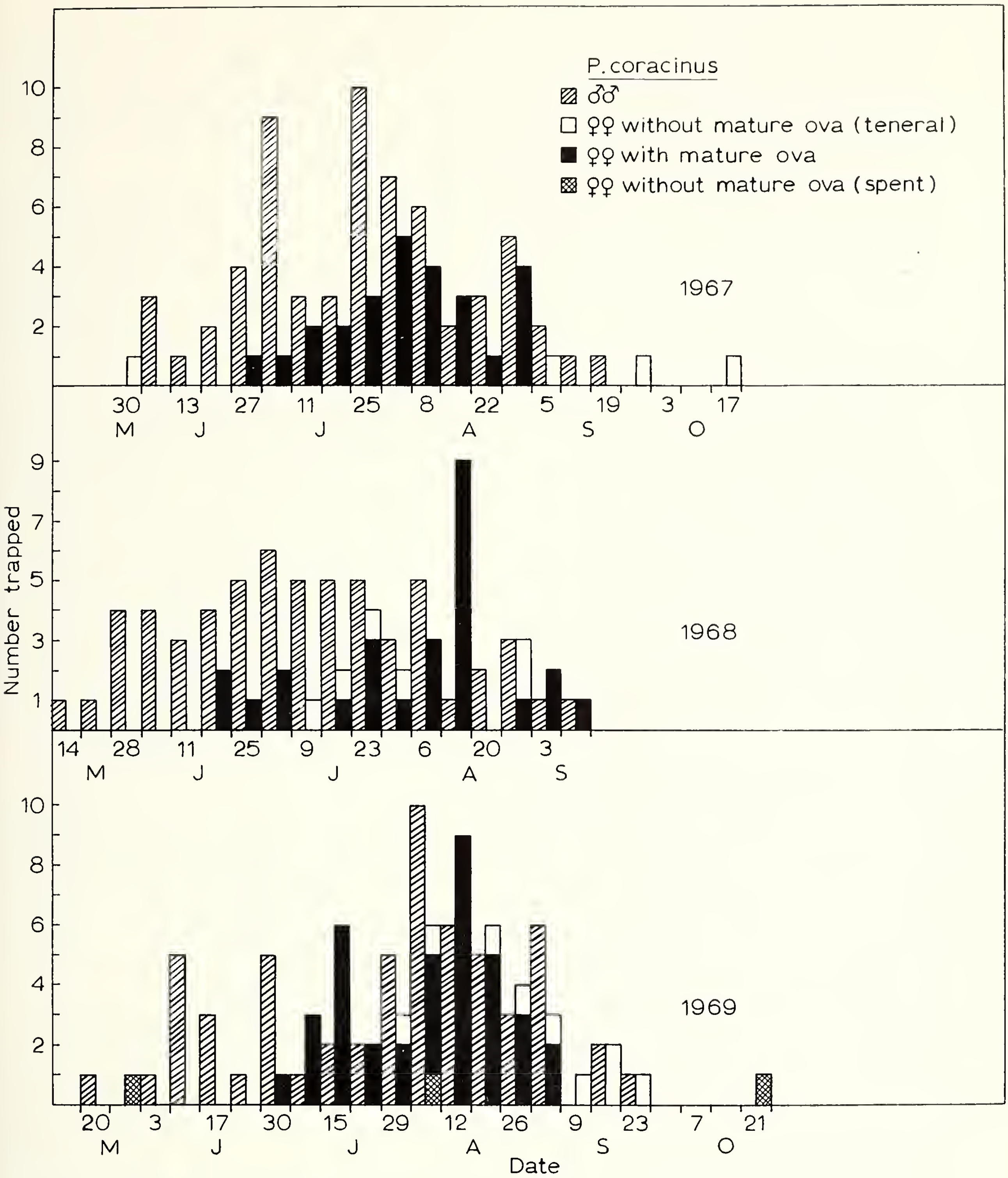

Fig. 2. Number of adult *P. coracinus* trapped per week, 1967–1969.

preceding August 27, 1968. Both teneral females trapped at this time in 1968 contained sperm and stored fat. A proportion of the progeny may mature in the same reproductive cycle but, although they may mate, they do not reproduce during that year but hibernate as teneral females. The one female trapped May 30, 1967, four weeks before the main female component of the cycle, may represent that segment of the population. Lindroth (1966) also reported imaginal hibernation in this species.

Some spent females also overwinter. This is evident from the 1969 data. The first female trapped in spring and the last in autumn were both spent. The early female was caught one month before the appearance of any gravid females so it seems likely that it had overwintered in spent condition. Whether or not such females reproduce a second time is unknown.

Possibly gravid females also overwinter with a full complement of eggs. They more likely oviposit and then either die or hibernate as spent females. The earliest gravid females which appeared in the population may have wintered either as larvae or teneral adults. In the latter case, they must have remained inactive until gravid since males were usually active for four or five weeks previously.

The teneral females trapped during July, 1968 (Table 2) represented about half the adult female population, assuming that gravid and teneral females were equally active and therefore trapped with the same frequency. These tenerals were likely derived from overwintered larvae rather than from eggs laid by the present generation because only one month had elapsed since the appearance of gravid females in the population. This hardly seems time for development from egg to adult. Thiele (1961) recorded two weeks as the minimal duration of even the first larval instar of *P. vulgaris* L. Teneral females trapped after July were likely progeny from the present reproductive cycle.

P. lucublandus

Two cycles per year were distinguishable in this species (Fig. 3). The spring cycle extended from mid-April or beginning of May to beginning or mid-August and the second cycle from mid-August to the end of October. As with *coracinus*, temperature influenced initiation of the spring cycle which began two weeks earlier in 1968 than in the much cooler spring of 1967. The peaks of both cycles also occurred earlier in 1968 than in 1967.

This species is a spring breeder. Gravid females began to appear in the population about two weeks after the beginning of the first cycle. As females matured, the proportion of tenerals in the population decreased (Table 2). From about the third week in May until early July, nearly all females were gravid. Toward the end of the first cycle, the proportion of teneral females again increased. These individuals were probably derived from eggs laid earlier in the same cycle. The fate of these females is uncertain. Eight out of nine of them in 1968 were fertilized and the ovaries were partially developed. If these females survive the winter, they must enter reproductive diapause and hibernate directly. In any case, they do not occur in the second cycle.

All females in the second cycle were sexually immature and many were callows, i.e., newly emerged beetles whose cuticle had not yet hardened. None of the females examined from this segment of the population in 1968 had been fertilized. This cycle is composed entirely of progeny from individuals of the first cycle

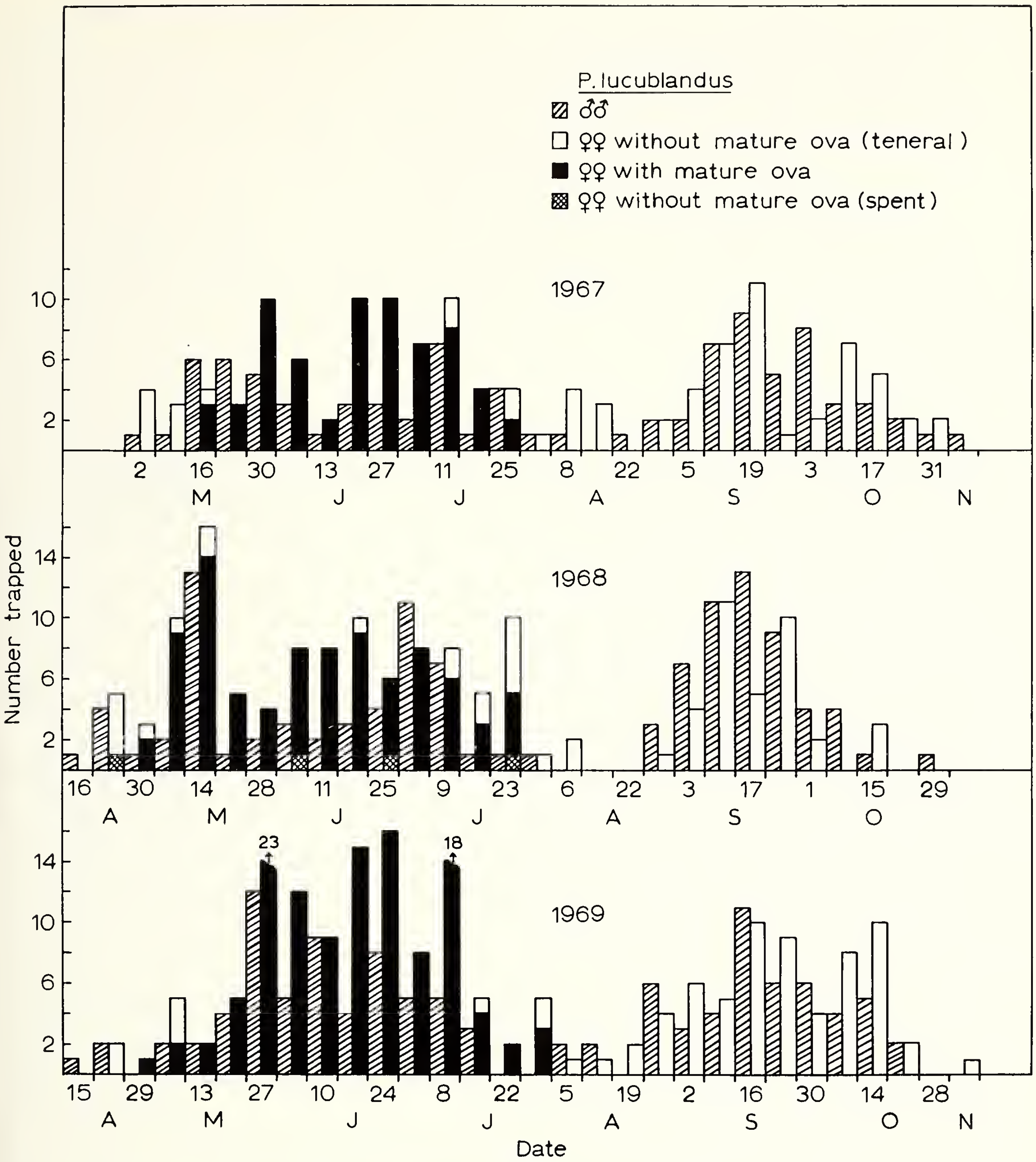

Fig. 3. Number of adult *P. lucublandus* trapped per week, 1967–1969.

and has nothing to do with reproduction. Activity at this time is connected with feeding and the search by newly emerged adults for suitable hibernation sites. These beetles overwinter in reproductive diapause.

A number of spent females was found in the first cycle in 1968 but none in the second cycle. Some spent females from the spring cycle generally must be present, however, and likely overwinter, as evidenced by the one spent female trapped April 23, 1968 before any gravid females had appeared. If locomotor activity of spent females is reduced, as Vlijm (1968) noted for *Calathus*, they may be present in the population during the second cycle but are not trapped.

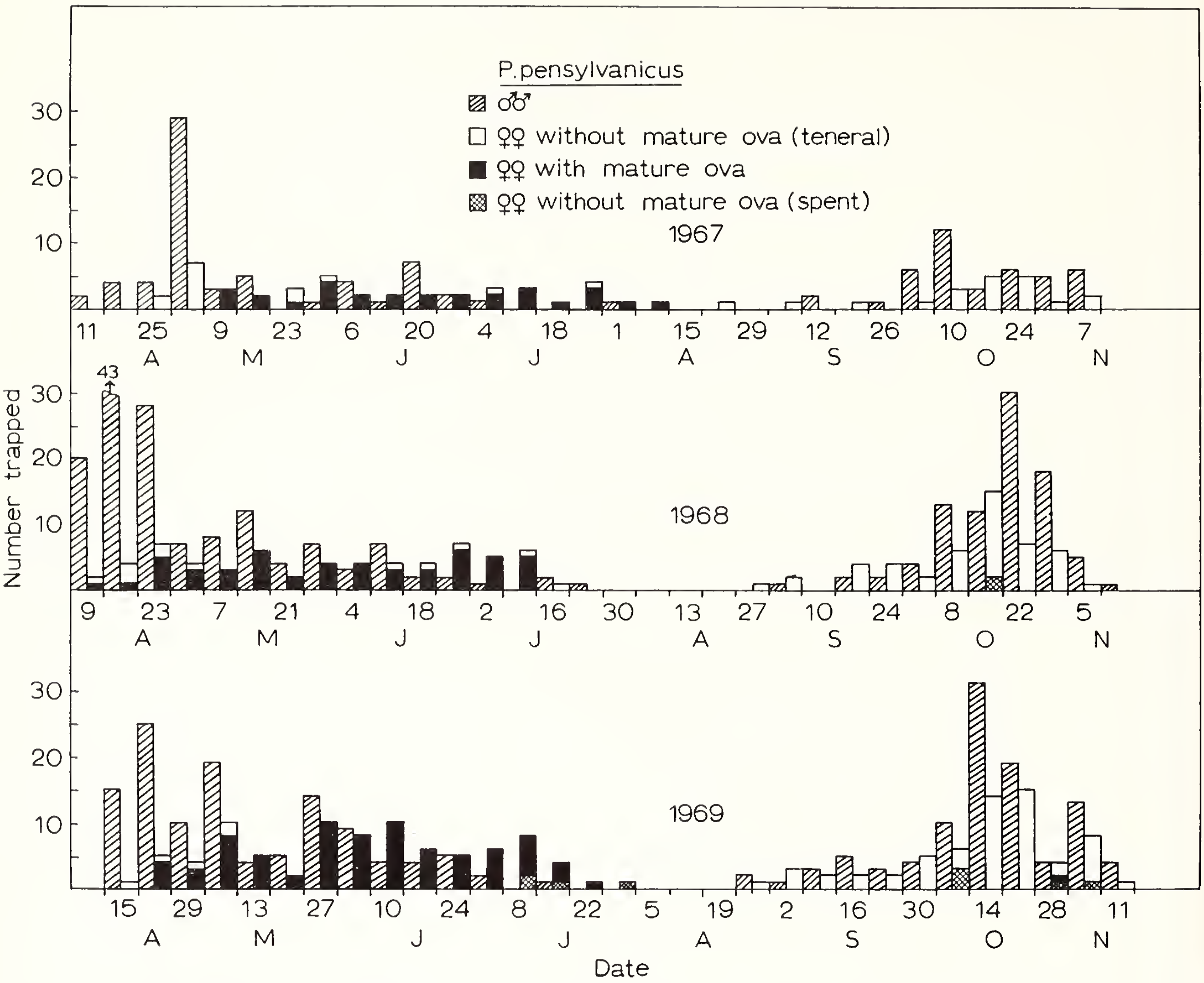

Fig. 4. Number of adult *P. pensylvanicus* trapped per week, 1967–1969.

P. pensylvanicus

This species also had two cycles per year (Fig. 4); the first extended from mid April to mid or end July and the second cycle from early September to the first or second week in November. Males were more active than females during the first few weeks of the spring cycle. Number trapped appeared to be related to temperature. In the exceptionally warm spring of 1968, 50% of the first cycle occurred by April 23; in 1967, 50% occurred nine days later.

Reproduction among *pensylvanicus* occurred in the spring and, as with *lucublandus*, was confined to the first cycle. Most females in the population were tenerals (Table 2) during the first two weeks of their activity in the spring as progressively more females emerged from hibernation. These early tenerals in 1968 carried sperm and the ovaries were already enlarged. During the next six to eight weeks, nearly all females in the population were apparently gravid. The appearance of a small proportion of teneral females after this until the end of the first cycle in 1967 and 1968 reflects the introduction into the population of newly emerged females produced from eggs laid in April and May. Some spent females occurred toward the end of the first cycle in 1969.

Individuals composing the second cycle are derived mostly from eggs laid during the spring cycle. Active females in the second cycle were tenerals with a small proportion of spent females from the first cycle. In 1969, one gravid female was trapped on October 28 for which there is no immediate explanation. One-quarter of individuals of the second cycle were callows and females from this cycle had small, immature ovaries and considerable stored fat. The males also contained large stores of fat at this time. This species overwinters largely as adults, the females as tenerals in reproductive diapause. There is no evidence to indicate whether spent females and larvae overwinter. Considering the relative size of the population which composed the second cycle, it seems that progeny from the spring reproductive cycle complete development before winter.

The autumn cycle of *pensylvanicus*, similar to *lucublandus*, has nothing to do with reproduction but with the search for food and hibernation sites. An essential difference, however, between the two species is that sexual activity may occur during the second cycle in *pensylvanicus*. Sperm was found in the spermathecae of 14 out of 31 females examined from the second cycle in 1968. It is possible that some of these females emerged during the first cycle, were fertilized, then entered reproductive diapause to become active later in the second cycle. All teneral females toward the end of the first cycle in 1968 had been fertilized. However, 70% of a sample of males examined from the second cycle had well developed testes in which sperm were abundant both in the apical portions of the testes and throughout the vasa defferentia. The rest had small, immature testes in which sperm were not obvious. Copulation may occur during this time although this was never observed. The fertilized females of the second cycle had ovaries sufficiently developed to be clearly visible although they contained no mature ova. The unfertilized beetles had immature, inconspicuous ovaries. None of the callow females examined was fertilized. It appears, as was suggested for *melanarius*, that fertilization may stimulate ovarial development but, during this time, development is halted by a reproductive diapause at an immature stage before the maturation of ova.

P. mutus

Phenologically, this species is similar to *lucublandus* and *pensylvanicus*. Two distinct cycles of adult activity occurred per year (Fig. 5). The first cycle began in mid-April and ended usually the first week in July. The second cycle extended from the latter half of September to the first or second week in November.

Reproduction in this species was confined to the spring cycle during which most of the active females in the population were gravid. In 1968, one teneral female was trapped toward the end of this cycle. As with the other species, such individuals represent the new generation from eggs laid earlier in the same cycle.

The second cycle was composed of progeny from the spring cycle. Nearly all

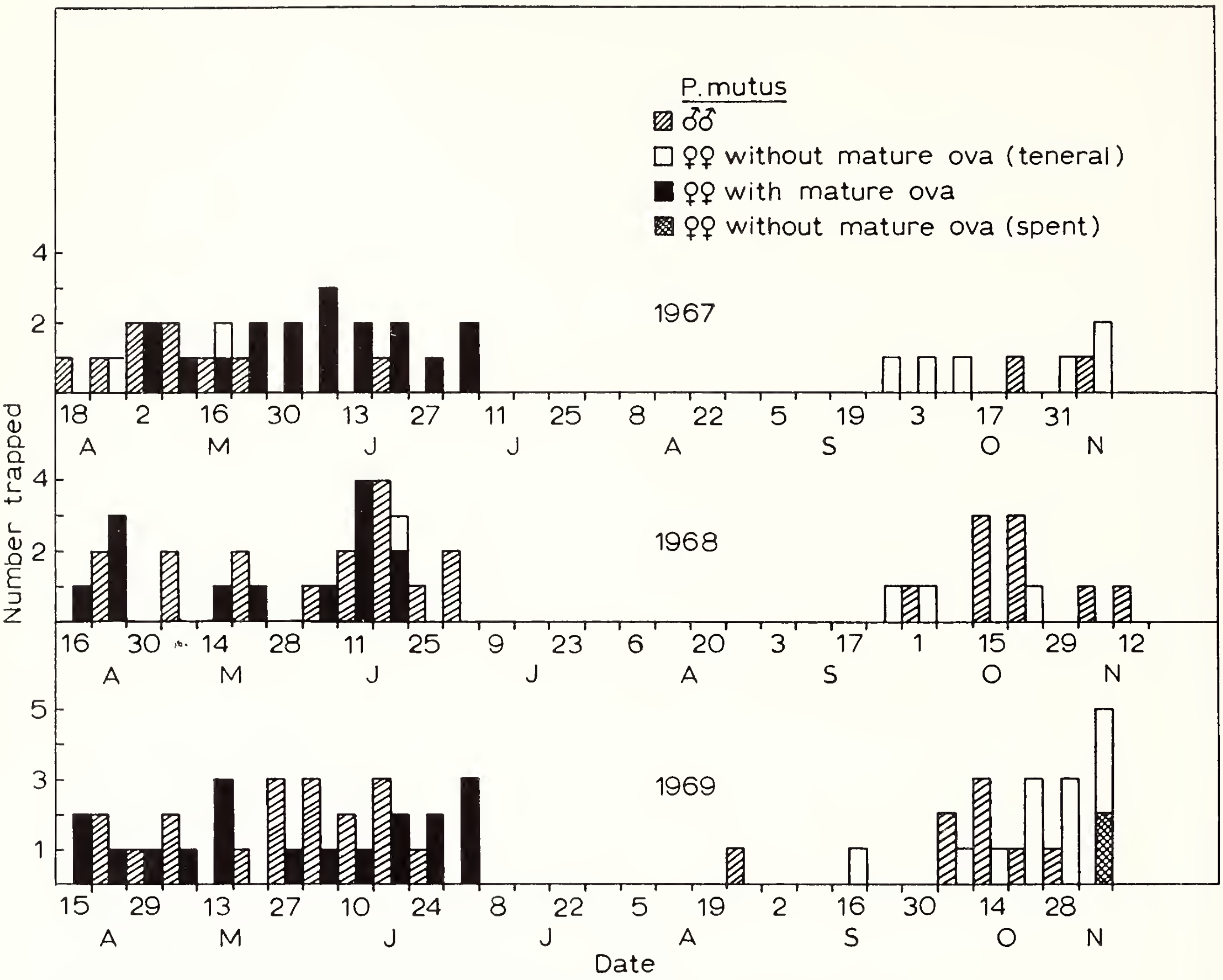

Fig. 5. Number of adult *P. mutus* trapped per week, 1967–1969.

females trapped at this time were sexually immature and unfertilized. Exceptions were two spent females captured at the end of the second cycle in 1969. This indicates that at least a small proportion of females from the spring cycle survive the mid-summer period of inactivity to become active later in the second cycle. Whether or not these individuals overwinter is speculative.

The immature beetles composing this second cycle must certainly overwinter. Both sexes trapped during this time contained large stores of fat, in advance of hibernation.

FECUNDITY

The number of mature eggs per gravid female in the 1968 catch was counted. Since the frequency distribution of egg numbers was not normal, the median egg number was determined, rather than the average, and is shown in Table 3. The maximal number of eggs carried at any one time was found in *melanarius*. It is doubtful, however, whether maxima are valid measures of total fecundity since some eggs may have been laid before capture or more might have been produced subsequently. Most gravid females contained ova in various stages of

Table 3. Median numbers of mature eggs per gravid female during 1968. Numbers in parentheses indicate range.

Species	Median No. eggs
P. melanarius	14 (1–49)
P. coracinus	12 (2–34)
P. lucublandus	12 (1–34)
P. pensylvanicus	7 (1–24)
P. mutus	18 (2–25)

development. It therefore seems that the number of mature eggs may provide an estimate of the rate of oviposition.

Fig. 6 shows the median number of mature eggs per gravid female in 1968 plotted against time. Assuming that the number of mature eggs contained is proportional to the rate of egg-laying, this rate remained uniform over much of the reproductive cycle of those species which overwinter principally as teneral adults, i.e., *lucublandus, pensylvanicus,* and *mutus.* Among *melanarius* and

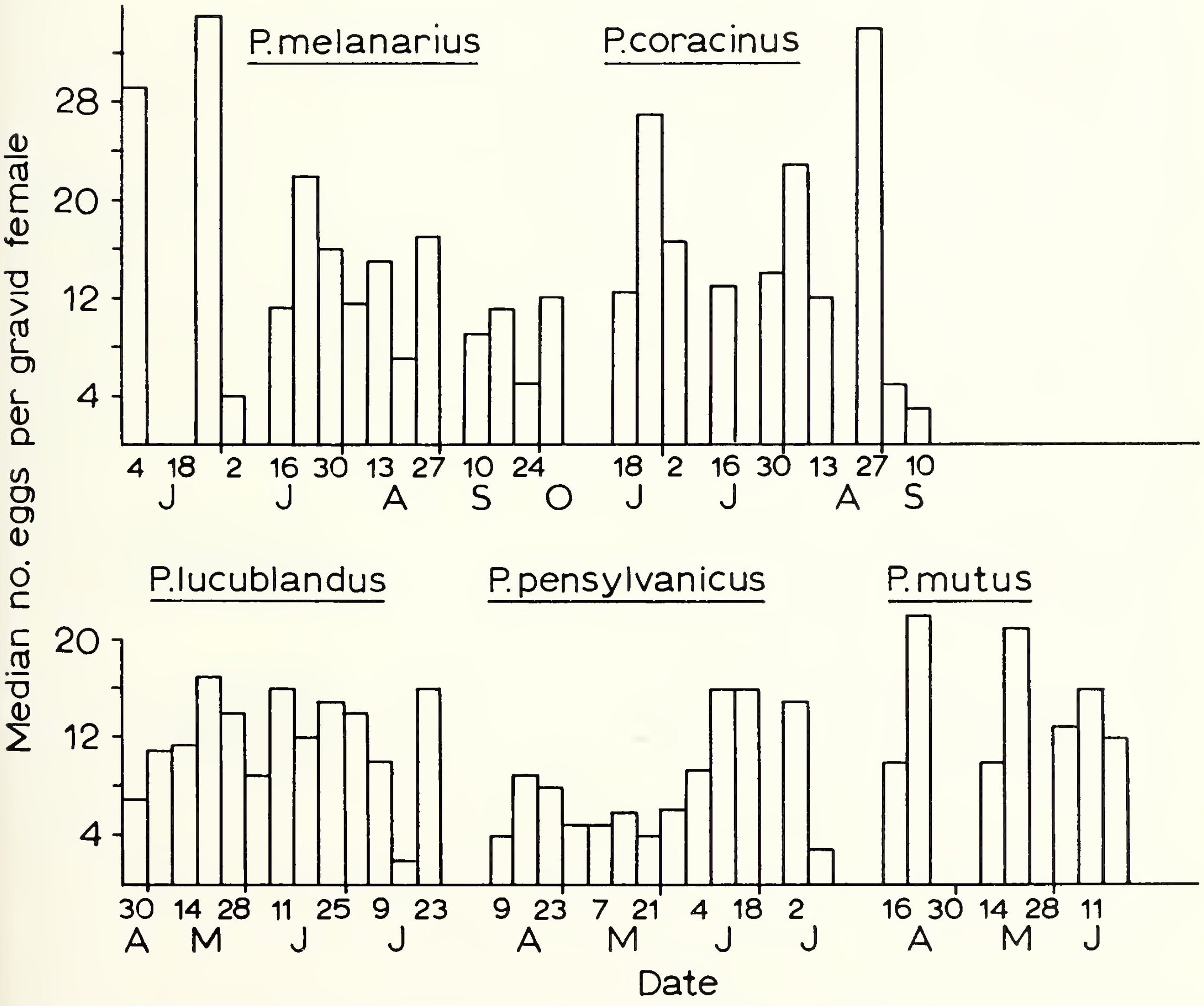

Fig. 6. Median number of mature eggs per gravid female at different times during 1968.

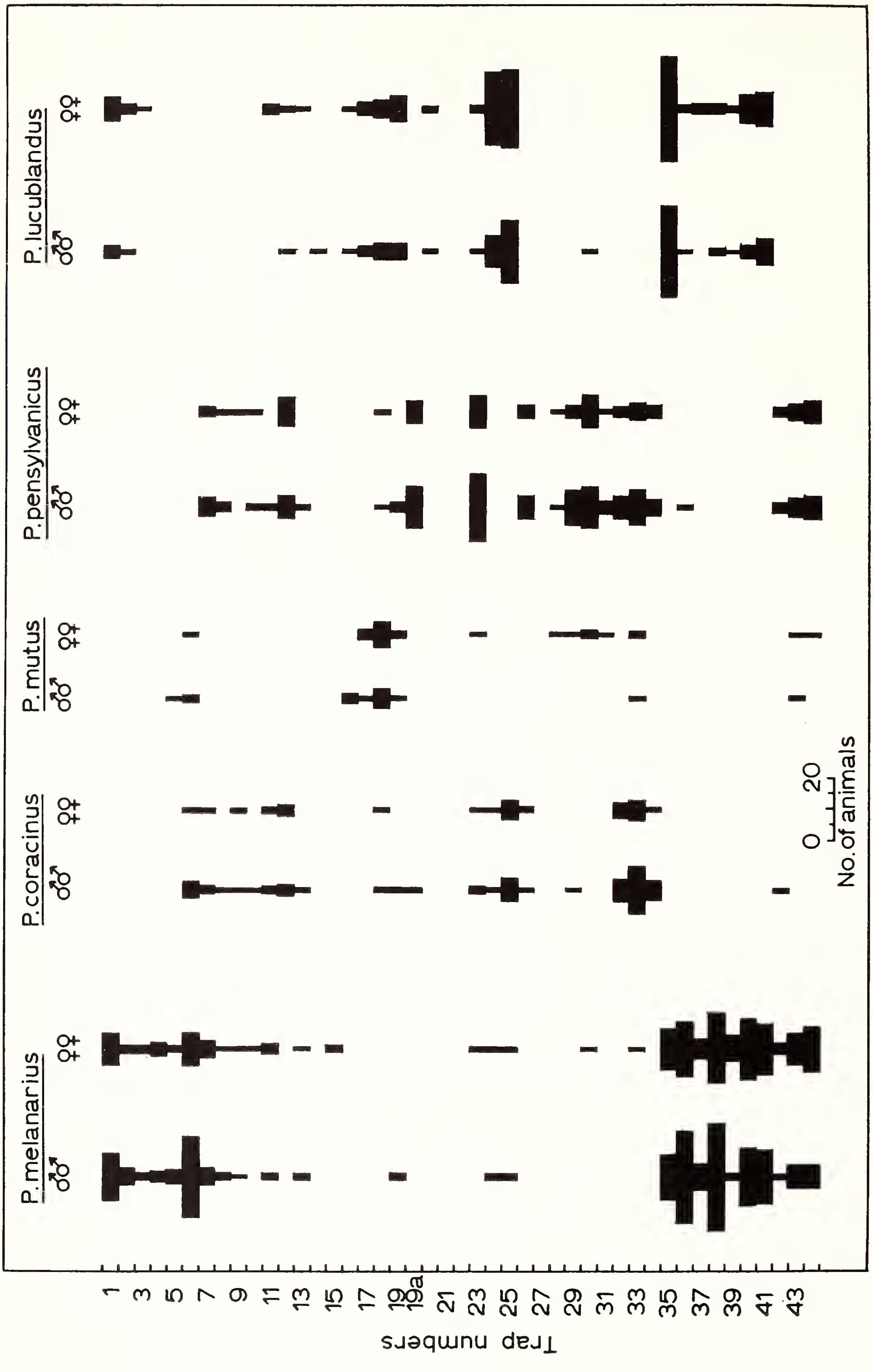

FIG. 7. Mean number of *Pterostichus* adults collected per trap, 1966–1968.

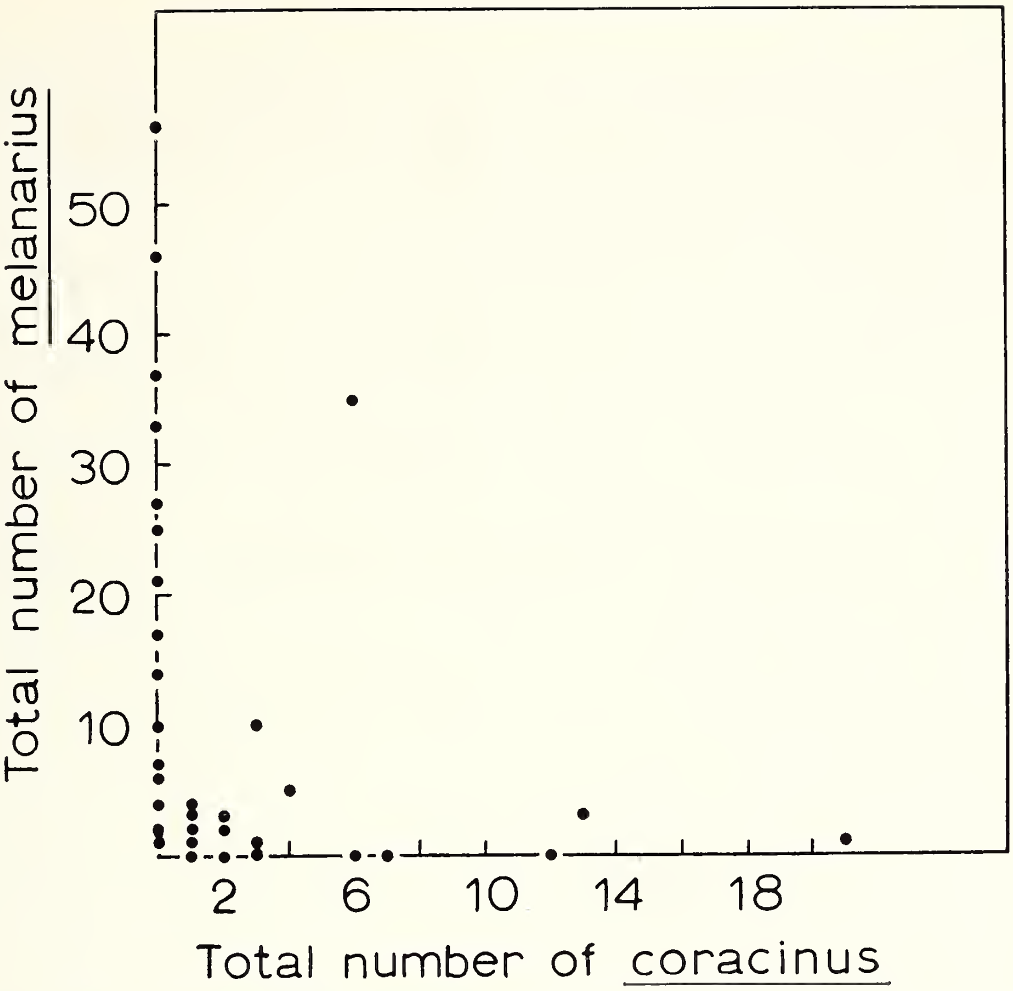

Fig. 8. Relation between total numbers of *P. melanarius* and *P. coracinus* collected per trap in 1968.

coracinus, however, which may overwinter partly as adults, the rate for the first females of the reproductive cycle was high. This suggests that many of these individuals may have overwintered as pre-reproductive adults and therefore reached maximal fecundity rapidly. The median number of eggs subsequently dropped before rising again suggesting the appearance in the population of recently emerged individuals which had overwintered as larvae and therefore were slower reaching maximal oviposition-rate.

ECOLOGICAL DISTRIBUTION

Fig. 7 shows the average number of adults of each species collected in each trap over the years 1966 to 1968 inclusive. The distributions of the sexes, in each case, were similar. No significant seasonal differences in distribution were observed.

P. melanarius

This species occurred in open or semi-open country and in both cultivated and uncultivated land. It was also found in deciduous and coniferous forests. It avoided barren places and preferred areas with deep, rich soil.

P. coracinus

Most individuals of this species were trapped in forest or forest edge and damp poorly drained soil. It avoided open, dry places but occurred to some extent on rocky, shallow soil as not completely devoid of vegetative cover. It was not found in cultivated terrain.

At least on a quantitative basis, and granting the intrinsic difficulties of making numerical comparisons from pit-trap data, *coracinus* and *melanarius* appear negatively associated. The greatest numbers of each species occurred where the other was scarce or absent, with one exception (Trap no. 6). For both open grassland and woods, where *melanarius* was numerous, *coracinus* was absent and where *melanarius* was scarce, *coracinus* was numerous (Fig. 8).

At present, it is speculative whether or not this differential distribution is the result of competitive displacement or merely the response to different environmental requisites. There is reason to believe that some form of mutual interference may occur between these two species. They are similar in both external and internal form and in some aspects of their ecological relations. However, *melanarius* is an introduced species which is spreading rapidly into areas occupied by *coracinus* (Lindroth, 1966). The solution of this problem requires further information on the ecology, particularly the feeding habits, of the two species.

P. mutus

This species was found in both coniferous and deciduous woods or at the edge of woods but occasionally in partly open country with sandy, humus-deficient substrate. It avoided open grassland.

P. pensylvanicus

This is a typical forest species; the greatest numbers were trapped in forest or forest edge. The limiting factors in distribution seem to be some characteristics of high forest, such as cover or presence of litter. It avoided open areas and even open areas covered by long grass. The distribution may be restricted by light. Thiele (1964) determined experimentally that, among 23 species of Carabidae, the determining factors in the distribution of most forest species were light and humidity.

P. lucublandus

This is the only species which was restricted to open country or forest edge. Only one specimen in three years was taken within a deciduous forest. It avoided barren ground but occurred in areas with rich grass cover. Preliminary observations suggest that this species is diurnal in activity and that the other four species are nocturnal.

DISCUSSION

Much has been written about the efficiency of pitfall traps in providing quantitatively valid population estimates. Greenslade (1964) noted weaknesses in this method which are applicable to carabid populations. Briggs (1961) concluded that the number trapped has little relation to the actual size of the population. But Banerjee (1970) has shown, at least with millipedes, that there is a direct relationship between density of animals and the number trapped up to a level of about 200 individuals per 81 m^2 which is probably above most naturally occurring millipede densities. However, he did not mention the type of terrain on which his experiments were conducted and this may also influence the catch.

Another inaccuracy inherent in pitfall data occurs if trapped individuals are not released. When numbers are compared in successive generations of the same species, the number of individuals extracted from the population in generation n may be expected to reduce the number of individuals in the population and therefore the catch in generation $n + 1$. This may be especially true of isolated populations which reproduce slowly and change little due to emigration or immigration. The reduction in numbers trapped among *Pterostichus* species from 1966 to 1967 could be ascribed to this trapping artifact. Nothing is known about the mobility of these populations but the amount of immigration might effect the speed at which and extent to which populations subsequently return to their initial size. Similar observations were made by Barlow (1957, 1958) on millipede populations. Briggs (1961), however, found no depletion of carabid populations in strawberries due to trapping. In any case, caution is necessary when interpreting pit-trap data.

The main difficulty in explaining phenological changes is to separate the activity and abundance components of the population which influence numbers trapped. There is some indication that initiation of activity in the spring among these species is partly due to the effect of temperature on emergence of adults from hibernation or the metamorphosis of overwintered larvae. The decline in numbers in the fall is no doubt partly due to progressive reduction in locomotor activity with falling temperature and the beginning of hibernation. Added to this, among the summer breeders at least, must be the death of a proportion of the spent individuals.

Reduction of numbers during mid-summer among the spring breeders with two cycles per year is due largely to the inactivity and/or death of spent individuals from the reproductive cycle before emergence of the main body of young beetles of the autumn cycle. Larsson (1939) noted among Danish spring breeders that the old beetles died rapidly after reproduction. However, it is unlikely that this is the only reason for the mid-summer decline in occurrence since there is evidence (Figs. 3, 4, and Table 2) in both *lucublandus* and *pensylvanicus* that young imagines are active toward the end of the spring reproductive cycle. The fate of these individuals is unclear. Among *pensylvanicus,* they may become active again during the autumn cycle. With *lucublandus,* this does not happen; so if these beetles survive, they must enter hibernation directly. This would account for their disappearance at this time. Also, the occurrence of spent *pensylvanicus* and *mutus* females during the autumn cycle indicates, that some individuals which were active during the spring cycle survive the summer decline and resume activity later. These individuals, however, form only a small proportion of the autumn peak which consists of newly emerged adults seeking hibernation sites. The mid-summer decline in numbers may be caused by several factors. Among some carabids with two cycles per year and which breed during the second cycle, the reduction of activity in mid-summer can be ascribed to a diapause of the total adult population (Penney, 1966). With *Pterostichus,* however, the situation is complicated by the juxtaposition of two successive generations around the summer decline.

The observed breeding periods agree with information previously published for most of these species. One exception is Rivard's (1964) observation of gravid female *pensylvanicus* in August, September, and October. With one exception during the present work, only young, sexually immature *pensylvanicus* females were found at that time.

Pterostichus seem to be spring breeders which overwinter as adults. Ten of the 14 species described by Larsson, (1939), Dawson (1965), Greenslade (1965), and the present work are in this category. These species have two activity-abundance cycles per year although this characteristic is variable depending on geographic distribution, (Greenslade, 1965). The remaining four species are summer-autumn breeders, with one cycle per year, which overwinter as larvae although *melanarius* and *coracinus,* hibernate more or less frequently as adults. Larsson (1939) noted that although such "Herbsttieren" overwinter mainly as larvae, a certain proportion of adults also overwinters but these die before the next breeding period.

The maximal number of mature eggs counted in any one female was higher than Rivard's (1964) records. However, this could be a function of the collecting techniques. Rivard used pit-traps but emptied them twice per week. In this study they were emptied only once per week. If females develop and lay eggs intermittently over a period of time, they may continue to produce mature eggs after falling into a trap but retain them because they lack the stimulus of a suitable oviposition site. Thus, the number of mature eggs can be expected to be greater if collections are made once rather than twice per week.

Since eggs may not be laid all at once, the average or median number of eggs may be a more meaningful indication of potential fecundity of these species. Murdoch (1966) stated that, with some *Agonum,* the number of mature eggs in a female was proportional to the rate at which it was ovipositing. He also observed that eggs in all stages of development were present in gravid females. In addition, he found a correlation between mature egg number and subsequent number of larvae and new adults. Briggs (1957) and Penney (1966) reported that other Carabidae oviposit intermittently over an extended time.

Comparing Tables 1 and 3 emphasizes that median fecundity bears little relation to the absolute size of any species population in an area, assuming that numbers trapped are a valid indication of that size. *P. mutus*, which had the highest median fecundity in 1968, had the smallest population. The reverse was true of *pensylvanicus*. The value of observations of fecundity is restricted to assessing possible changes in numbers in successive generations of the same species and in determining times of maximal reproduction.

The present observed distributions agree with reports on the same species by Lindroth (1966) and Rivard (1964). Minor exceptions are Lindroth's record of *coracinus* in open fields and meadows and Rivard's account of the same species on dry soil. During the present study, *coracinus* was not observed in open, dry places.

Greenslade (1965) and Thiele (1964) noted connections between temporal-spatial distribution of carabids and their breeding type. Greenslade reported that winter larvae and late summer activity predominate among species in woodland habitats whereas there is earlier activity and greater adult over-wintering of species in grassland. The present species do not entirely conform to these generalizations. *P. pensylvanicus* is confined to wooded areas, over-winters in the adult stage, and is active early in the spring. The other woodland species, *coracinus*, is not typically active in late summer.

Among the species which Thiele (1964) studied, spring breeders occurred only in cool, moist forests. The explanation given for this was that the vulnerable larval stages occurred in summer, the time of greatest heat and dryness. Therefore, the species were restricted to moist, cool places. The larvae of autumn breeders, however, were present when the weather was cooler and damper. Such species, therefore, were not confined to woods. Two of the present five species, *lucublandus* and *coracinus* do not comply with this pattern; *lucublandus* is a spring breeder found in open country; *coracinus* is a summer breeder and occurs in forest or forest edge. It is doubtful whether such temporal-reproductive relationships have much influence on the distribution of these species because their larvae are mostly subterranean and therefore protected from excessive heat and desiccation.

Larsson (1939) also recorded correlations between distribution and phenological relationships of Danish carabids. Among the group which he designated as "Herbsttieren," i.e., those which breed in summer and autumn, he reported that the reproductive maximum occurred earlier in forest biotopes. This was due to the winter temperature being less severe in woods than in open areas thereby permitting more rapid maturation of overwintered larvae. This relationship could not be verified in the present work. With *melanarius*, which inhabits both wooded and open areas, no consistent difference was evident in timing of reproductive cycles in the two segments of the population which occurred in these two habitat types.

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Proceedings of the New York Entomological Society

(Meetings held in Room 129 of the American Museum of Natural History
unless otherwise indicated.)

Meeting of October 7, 1969

President David Miller presided; 16 members and 7 guests were present. Dr. John Cooke, formerly of Oxford University was introduced to the members of the Society. Dr. Cooke is an arachnologist on the staff of the American Museum of Natural History. Proposed for Active Membership were: Mrs. MaryAnn Karpel of Mt. Kisco, New York whose interest is insect pathology and Miss Joan Todd of New York City. Proposed for Student Membership was Mr. Guillermo Alvarado, a student in the Department of Entomology at the University of California at Davis who is interested in arachnids.

PROGRAM. **Scanning Electron Microscopy and its Application in Entomology.** Mr. Frederick Miller, Jr. discussed the history and operation of the scanning microscope. By using prepared and living specimens of lice and fleas, Mr. Miller demonstrated the surface detail that can be achieved by using this instrument. (An abstract follows.)

The meeting was adjourned at 9:15 P.M.

Howard Topoff, *Sec.*

SCANNING ELECTRON MICROSCOPY AND ITS APPLICATION IN ENTOMOLOGY

The initial concept of the scanning electron microscope may be attributed to Knoll in 1935. Thirty years later the first commercial scanning electron microscope became available. It has rapidly become a valuable tool in entomology. Morphologists and physiologists are now able to study fine surface details in relationship to other structures as well as the surface as a whole, at higher magnification and greater depth of field than with the light microscope. Taxonomists enjoy the ease of counting and measuring the various setae and plates. Evolutionists are able to see minute structural changes in species, which will eventually lead to a better understanding of their phylogenetic relationships.

Although the specimens are usually cemented to the specimen stub and coated with approximately 200A. of gold, or some other metal, uncoated and even live material may be studied under some conditions.

Studies of the antennal structures of the Anoplura show the "ring sensorium" described by Ferris (1951) on the fourth and fifth segments to be sensilla coeloconica. The pegs at the base of the sensilla have numerous projections protruding from their apex. The number and size of these projections have been found to vary from species to species. The openings of the sensilla coeloconica also vary in size from species to species. When no sensilla coeloconica are present, sensilla basiconica are located in their place. The apices of the stalks of the sensilla basiconica have numerous projections which vary in size from species to species. Two pore organs are usually found close to the sensilla on the fifth or terminal segment. The stalks appear capable of retracting into the segments; Because: the pegs of the two types of sensilla are similar; the sensilla basiconica are present when the sensilla coeloconica are not; the two structures are found in the same antennal locations; and the smaller sensilla coeloconica openings have two pore-like organs close to them which are similar to the pore organs of those seen near the sensilla basiconica, it seems that one sensilla is a modification of the other. There is evidence that the phylogenetic relationships of the Anoplura may be evaluated by using these sensilla and their modifications. Studies of this possibility are currently in progress.

Frederick Miller, Jr.

Meeting of October 21, 1969

President David Miller presided; 20 members and 8 guests were present. Elected to Active Membership were Dr. MaryAnn Karpel and Miss Joan Todd. Mr. Guillermo Alvarado was elected to Student Membership. Proposed for Active Membership was Mr. Edward Konig of the Bronx, New York. Dr. Miller announced that the New York Entomological Society sent a donation last spring to the Zoological Record in support of their publication which abstracts and indexes literature published in biological journals. The Society has received a letter of appreciation for its donation. Dr. Miller announced that the nominating committee consists of Dr. Elsie Klots, Mr. Bernard Heineman and Dr. James Forbes. The President also announced that Dr. Kumar Krishna and Mrs. Valerie Krishna were appointed as Editors of the Society's publication ENTOMOLOGICA AMERICANA.

PROGRAM. **Biological Control of Aphids.** Father Daniel Sullivan of Fordham University discussed the various methods used in controlling insect pests and stressed the use of entomophagous insects in controlling aphids. (An abstract follows.)

The meeting was adjourned at 9:20 P.M.

Howard Topoff, *Sec.*

BIOLOGICAL CONTROL OF APHIDS

A fairly safe prediction is that the problem of man and the contamination of his environment will be the focus of world concern during the 'seventies. In the area of insect pest control, however, banning of DDT and other insecticides is often a negative approach and imaginative alternatives must be found to complement—if not replace chemical control.

Biological control is such an alternative, based on principles which try to restore the predator-prey, parasite-host relationships as they exist in nature. This usually involves determining the original country from which the insect pest was "imported" and then searching for its natural enemies. These are then introduced and colonized in the host country in an attempt to re-establish the original balance of nature.

Aphids are economically important insect pests throughout the temperate regions of the world on agricultural crops, ornamental plants, and trees. The use of predators such as ladybird beetles to control aphids is well-known, but the existence of tiny wasps (Order Hymenoptera, Families Aphidiidae and Aphelinidae) is frequently overlooked.

These parasitic wasps are specific in attacking certain species of aphids. The female wasp lays an egg inside an aphid, and after hatching—the endoparasitic larva gradually devours and kills the host aphid, over a period of 8 days. The wasp larva spins a cocoon inside the dead aphid (now called a "mummy") and also pupates there. Four days later (or about 12 days from the time the egg was originally deposited)—an adult wasp emerges from the mummy, ready to mate, and repeat the cycle

In nature other wasps (called secondary parasites or *hyper*parasites) attack the first wasp (or primary parasite) while it is still developing inside and devouring the original host aphid.

Daniel Sullivan

November 4, 1969—Election Day—No Meeting

Meeting of November 18, 1969

President David Miller presided; 16 members and 8 guests were present. Mr. Edward Konig was elected to Active Membership. Proposed for Active Membership were: Mrs. Adrian DeWind of New York, N.Y.; Dr. William Gotwald of Utica, New York and Dr. J. E. McPherson of Carbondale, Illinois. Mr. Joseph S. Butscko was proposed for Student Membership.

PROGRAM: **Insect Collecting in Central America.** Mr. Ginter Ekis of Rutgers University spoke of his experiences in Central America and showed slides of various plants and animals he encountered.

The meeting was adjourned at 9:20 P.M.

Lee H. Herman, *Sec. pro. tem.*

Meeting of December 2, 1969

President David Miller presided; 20 members and 11 guests were present. Mr. Edwin Sexton of Middletown, New Jersey was proposed for Active Membership. Mr. Sexton is interested in stored-product entomology and pesticides.

Miss Nora Churns was proposed for Student Membership. Miss Churns is a student at City College and is interested in entomology in general. President Miller introduced the retiring president of the Jr. Entomological Society, Mr. Jamin Eisenbach. Mr. Eisenbach discussed the Jr. Society's summer field trip to the American Museum of Natural History's Southwestern Research Station in Arizona. Mr. Raymond Mendez, a former member of the Jr. Society and presently a Scientific Assistant in the Department of Entomology at the American Museum of Natural History, showed slides of insects and plants from the Southwestern Research Station.

Dr. Miller informed the Society that a road was proposed by the Tri-State Highway Commission, to be built through the Ward Pound Ridge Reservation. Last spring the New York Entomological Society sent a letter to the Tri-State Commission asking that they reconsider the route of this proposed road so that it would by-pass the Reservation. The Society also sent letters to other entomological societies asking for their support. The New York Entomological Society has received a letter from the Connecticut Society, supporting our proposal and noting that they had sent their own letters of protest to the highway agency concerned.

PROGRAM. **Communication in Army Ants.** Dr. Howard Topoff discussed trail-following behavior and its development in army ants in relation to social organization. (An abstract follows.)

COMMUNICATION IN ARMY ANTS

Army ant colonies exhibit cyclic behavior, consisting of nomadic and statary phases which alternate throughout the functional season. For *Neivamyrmex nigrescens* in southeastern Arizona, cyclic activities are conducted from April through September.

The nomadic phase of *N. nigrescens* is characterized by high colony activity, exhibited by strong raids and nightly emigrations to new nesting sites. This phase is initiated by stimulation, both chemical and chemotactual, imparted to the adult workers by a newly eclosed callow brood. Although the callows emigrate with the colony on the first nomadic night, they do not participate in raiding activities. Since army ants raid and emigrate on a chemical trail laid down continuously from their hind-guts, experiments were designed to compare the sensitivity of adult and callow workers to the chemical trail.

An artificial trail was produced by killing 200 intermediate-sized adult ants in 10cc. of petroleum ether. The ants were then discarded and the ether used as a stock solution of trail substance. This solution was put into a microburette, suspended above a rotating phonograph turntable. In this way, a circle of trail substance was deposited onto a filter paper disc positioned on the turntable. Ants were placed on the filter paper, and allowed to cross the trail. If an ant followed the circular trail for one-half circle (180 degrees), it was considered to have followed the trail.

When adult and immature (callow) ant workers were tested on this artificial trail, the callows were found to be more sensitive than adults. This was indicated by the fact that a greater percentage of callows could follow the trail substance than adult workers from the same colony.

It is difficult to explain why callow workers do not participate in raiding activities during the first few days of the nomadic phase, since they are as sensitive or more sensitive to the species chemical trail then are adult ants. Perhaps the callows are also more sensitive to other chemical and tactual stimulation that is characteristically present in army ant nests. One hypothesis is that callow army ants remain in the nest during raiding, because their threshold for chemical and tactual stimulation is very low, and that they leave the nest to emigrate when this stimulation is reduced. This reduction in stimulation might take place when the adult ants leave the nest during an emigration.

HOWARD TOPOFF

Meeting of December 16, 1969

Vice-president Herman presided; 23 members and 24 guests were present. Mr. Edward Sexton of Middletown, New Jersey was elected to Active Membership and Miss Nora Churns of City College was elected to Student Membership. President Miller announced that the 14th International Congress of Entomology will be held in 1972 in Canberra, Australia. Anyone seeking information should see Dr. Miller.

PROGRAM. **Living Insect Photography: Methods and Examples.** Dr. Alexander B. Klots explained the operation of photographic equipment and its application to insect photography.

The meeting was adjourned at 9:20 P.M.

MICHAEL BOSHES, *Sec. pro. tem.*

Meeting of January 6, 1970—The Annual Meeting

President David Miller presided; 15 members and 23 guests were present. Mr. Buckbee, reporting for the Publication Committee announced the resumption of publication of **Entomologica Americana**, following our consolidation with the Brooklyn Entomological Society. The first copy of **Entomologica Americana** was presented to President Miller in appreciation of his efforts as President of the Society.

On behalf of the Nominating Committee, Mr. Heineman presented the list of candidates for the year 1970:

President—Dr. Lee H. Herman, Jr.
Vice-president—Dr. Howard R. Topoff
Secretary—Fr. Daniel J. Sullivan, S. J.
Assistant Secretary—Miss Betty White
Treasurer—Dr. Winifred Trakimas
Assistant Treasurer—Mrs. Patricia Vaurie
Trustees: Dr. David C. Miller, Dr. James Forbes
Publication Committee: Dr. Lucy Clausen, Chairman
Dr. Alexander B. Klots
Dr. Ayodyha P. Gupta

A motion was made and seconded that the candidates be elected. The entire slate was unanimously elected to office. After the election, President Lee Herman presided.

Miss Helen McCarthy of Astoria, New York, and Mr. Walter Kaufman of Jamaica New York were proposed for Active Membership.

PROGRAM. **Semi species of *Drosophila paulistorum*.** Dr. Theodosius Dobhansky of Rockefeller University, discussed the occurrence of hybrid species of *Drosophila* in Central and South America and experiments with artificial selection in the laboratory.

The meeting was adjourned at 9:40 P.M.

Daniel J. Sullivan, *S.J., Sec.*

Meeting of January 20, 1970

President Lee Herman presided; 15 members and 8 guests were present. President Herman announced that Dr. Lucy Clausen has accepted the Editorship of the Society's **Journal**. This creates a vacancy on the Publication Committee which will be filled by Dr. John Cooke. Miss Helen McCarthy of Astoria, New York and Mr. Walter Kaufman of Jamaica, New York were elected to Active Membership.

Miss Helen Claire Saraceni of Mt. Vernon, New York and Hunter College was proposed for Student Membership.

PROGRAM. **Recently Discovered Associations Between Moths and Mites.** Dr. Asher Treat, Professor Emeritus of Biology at the City University of New York spoke of many relationships which exist between moths and mites.

The meeting was adjourned at 9:55 P.M.

Daniel J. Sullivan, *S.J., Sec.*

Meeting of February 3, 1970

President Lee Herman presided; 13 members and 6 guests were present. Miss Helen Claire Saraceni of Mt. Vernon, New York and Hunter College was elected to Student Membership. Mr. John A. Serrao of St. Francis College was proposed for Student Membership.

PROGRAM. **Part I—The Entomologist and Part II—Ants and Their Search for Food.** Dr. William H. Gotwald, Jr. of the Department of Biology of Utica College, Utica, New York, in Part I, gave a humorous and informative presentation of the type of work done by a professional entomologist. In Part II his presentation was based upon his research on the feeding behavior of the carpenter ant—its search for food in the form of honeydew and as a scavenger. (An abstract follows.)

The meeting was adjourned at 9:30 P.M.

Daniel J. Sullivan, *S.J., Sec.*

ANTS AND THEIR SEARCH FOR FOOD

Metabolically, ants, similar to other animals, must procure adequate nutrients from which new protoplasm can be made. Complex patterns of food gathering have evolved in many species in response to these needs.

The food gathering behavior in a single colony of *Camponotus noveboracensis*, a carpenter ant, was presented. The colony had three food sources: the honeydew produced by the treehopper *Vanduzea arquata*; the sap exudate from a wound in the trunk of the common lilac *Syringa vulgaris* and dead insects. The behavior of the worker ants in seeking these sources was discussed.

Because this ant uses several food sources it is regarded as a generalized feeder. It can utilize several alternative foods and is able to adapt to changing food resources.

William H. Gotwald

Meeting of February 17, 1970

President Lee Herman presided; 15 members and 5 guests were present. Mr. John A. Serrao of St. Francis College was elected to Student Membership.

Dr. John A. Cooke of the American Museum of Natural History and Dr. Robert C. Dalgleish of Union College, Schenectady, New York were proposed for Active Membership.

PROGRAM. **Trassmission of Viruses by the Red-Banded Leaf Roller.** Dr. Mary-Ann Karpel of Rutgers University, New Brunswick, New Jersey explained that her research began with the problem of developing a medium for the mass rearing of the Red-banded Leaf Roller, which could then be used for studies on the transmission of a virus. The virus is transmitted by both sexes via the sperm as well as the egg. (An abstract follows.)

The meeting was adjourned at 9:20 P.M.

Daniel J. Sullivan, *S.J., Sec.*

TRANSMISSION BY THE RED-BANDED LEAF ROLLER

Indications of the occurrence of transovarial transmission were noted in colonies of red-banded leaf rollers (*Argyrotaenia velutinana,* Walker) being reared for the purpose of mass-producing a granulosis virus. Lengthened incubation time, low hatch rates, and discoloration of eggs laid by adults derived from infected larvae were noted.

Fewer pupae and adults were obtained from infected larval populations than from healthy larval populations. Selection pressure appeared to be heavier against females than against males, with females dying earlier and in greater numbers than males.

Eggs derived from infected females, both before and after fertilization with sperm from infected males, were studied with the electron microscope for the presence of whole virus granules. No evidence of the presence of whole virus granules, on or within the eggs, was found.

Transmission experiments, involving matings with infected males and infected females, infected males and healthy females, and healthy males and infected females, indicated that the virus was transmitted by the male as well as by the female. Apparently, some or all of the viral genome, rather than the whole granule, was transmitted.

Nucleic acids were extracted from the granulosis virus, the infected eggs and the healthy eggs. These extracts were studied with the aid of sucrose gradients, ultracentrifugation, and spectrophotometry. The nucleic acid profiles differed for healthy and infected eggs. It is theorized that the viral genome attaches to the host genome in one or several places.

Mary-Ann Karpel

Meeting of March 3, 1970

Vice-President Howard Topoff presided; 16 members and 11 guests were present. Dr. John A. Cooke of the American Museum of Natural History and Dr. Robert C. Dalgleish of Union College, Schenectady, New York were elected to Active Membership.

Mr. Herbert Sullivan was proposed for Active Membership.

PROGRAM. **Ecological Problems of the Proposed Sea Level Canal in Central America.** Dr. Charles Lacaillade of St. John's University, Jamaica, New York presented a history of the present canal through Panama, with special emphasis on the various diseases which hindered the construction of the canal. The ecology and epidemiology of malaria were discussed and the current aspect of research being done in the Canal Zone. The second part of his talk centered on the ecological studies being undertaken to determine what impact the proposed sea-level canal through Colombia may have on the flora and fauna of the area. The Meeting was adjourned at 9:40 P.M.

Daniel J. Sullivan, *S.J., Sec.*

Meeting of March 17, 1970

President Lee Herman presided; 25 members and 16 guests were present. Mr. Herbert Sullivan was elected to Active Membership.

PROGRAM. **Mating Behavior of Cockroaches.** Dr. Louis Roth of the U.S. Army Natick Laboratory, Natick, Massachusetts, demonstrated the behavioral postures involved in the mating of *Nauphoeta cinerea* by both a color motion picture and slides. Their behavior was compared with other species, and the question of what controls the inhibition of egg development after the transfer of the spermatophore was discussed. It was Dr. Roth's position that this inhibition is probably due to mechanical rather than hormonal influence. (An abstract follows.)

The meeting was adjourned at 9:15 P.M.

Daniel J. Sullivan, *S.J., Sec.*

MATING BEHAVIOR OF COCKROACHES

Olfactory, tactile, and contact chemoreceptive stimuli are principally responsible for patterns of behavior during courtship and mating of cockroaches. The corpora allata control the production of female sex pheromone in several species of Blatteria. In males of *Nauphoeta* *cinerea*, a pheromone (seducin) is produced on the tergites which induce the female to mount and palpate his dorsum. The female's position above the male apparently is detected by pairs of abdominal vibration receptors found in each abdominal segment.

The firm insertion of the spermatophore in the bursa copulatrix results in mechanical stimuli which are transmitted to the brain, and the female thereafter does not respond to the male's pheromone; she will not mate again until after parturition. Transecting the nerve cord prior to or just after copulation, results in hypersexual female behavior, apparently because the inhibitory signals from the bursa cannot reach the brain.

During pregnancy the ovarian oocytes do not develop because the ootheca in the uterus inhibits the activity of the allata. There is experimental evidence to substantiate that this inhibition is due to mechanical stimuli resulting from the stretched uterus.

Louis M. Roth

Meeting of April 7, 1970

President Lee Herman presided; 16 members and 6 guests were present. Dr. Herman announced that Mr. Frederick Miller has been appointed a Trustee of the Society.

Mrs. Monica Topoff was proposed for Active Membership.

PROGRAM. **Transmission of Tumors by Insects.** Dr. Paul Woke of the American University, Washington, D.C. indicated that blood sucking insects such as mosquitoes and fleas could be the vectors of virus-induced neoplasms. The presence of similar tumors in domestic animals and house pets makes continued research in this area important in determining a possible relationship with human tumors and the role of insects as vectors. (An abstract follows.)

The meeting was adjourned at 9:25 P.M.

Daniel J. Sullivan, *S.J., Sec.*

TRANSMISSION OF TUMORS BY INSECTS

Tumors (Neoplasms: Galls, warts, cancers, leukemias) are abnormal growths of tissue occurring as diseases in many different kinds of plants, lower animals, and man. Insects are known to be capable of transmitting several tumor-inducing agents between animals. Certain virus-induced benign and malignant tumors of wild rabbits are transmissible from rabbit to rabbit by mosquitoes, conenose bugs, and fleas. Tumor cells in ingested blood from hamsters are apparently transmissible by mosquitoes and biting flies. Question: Are insects, ticks, and mites (arthropods) more significantly involved in the causation and/or transmission of tumors, particularly leukemias, than is known at present?

Arthropods have ample opportunities to acquire potentially infectious agents from tumor-bearing animals, to harbour these agents and to transmit and discharge them into recipients. While the animal body does resist such intrusions, tumors have developed following transmission, as in known communicable but non-tumorous diseases.

The feeding behavior of arthropods in nature is suited to natural transmission of tumors; the sources of the inducing agents are readily accessible.

Reports in the literature on space, time, seasonal and associational relationships in leukemia cases often suggest insect transmission.

The insect-host relationship is often such that insects might induce tumors directly.

Our research is currently concerned with the mechanics of blood ingestion by arthropods in relation to the acquiring from tumorous hosts and the transfer to new hosts of causative agents, and the survival of these agents within the arthropod.

If tumors or leukemias of man's domesticated and economic animals or of man himself should be found to be transmissible by arthropods a further degree of control would be possible.

Arthropods as possible causative and transmitting agents should be taken into account along with other environmental factors in epidemiological investigations of tumor, particularly leukemia, cases.

Paul A. Woke

Meeting of April 21, 1970

President Lee Herman presided; 17 members and 6 guests were present. Mrs. Monica Hunt Topoff was elected to Active Membership. Dr. A. Dexter Hinckley of the Brookhaven National Laboratories, and Dr. Donald E. Etes of Park Forest, Illinois were proposed for Active Membership. Mr. Edward A. Martinko of Colorado University was proposed for Student Membership.

PROGRAM. Dr. Howard Topoff explained that the "Tribute to Dr. Theodore C. Schneirla," planned for this evening was cancelled because of the Passover Festival. It will be rescheduled for next fall. Dr. Topoff spoke on his **1965 Trip to Costa Rica**. Sponsored by the National Science Foundation, and in cooperation with various American Universities, a group of professors and students studied tropical ecology from the point of view of varied disciplines such as botany, zoology, entomology, herpetology, etc. This summer course has been repeated in succeeding years and was highly praised also by several members in the audience who had personal knowledge of this program.

The meeting was adjourned at 9:15 P.M.

Daniel J. Sullivan, *S.J., Sec.*

Meeting of May 5, 1970

President Lee Herman presided; 22 members and 7 guests were present. Mr. J. Huberman presented the report of the Auditing Committee. Dr. A. Dexter Hinckley of the Brookhaven National Laboratories and Dr. Donald E. Etes of Park Forest, Illinois were elected to Active Membership. Mr. Edward A. Martinko of Colorado University was elected to Student Membership.

PROGRAM. **Infestation and Survival of the Gyspy Moth.** Dr. A. Dexter Hinckley of the Brookhaven National Laboratories used color slides to demonstrate the infestations and capture of the gypsy moth. He also spoke of the various mortality factors that are involved. He briefly discussed other studies of radiation effects on plants and their insect fauna.

The meeting was adjourned at 9:30 P.M.

Daniel J. Sullivan, *S.J., Sec.*

Meeting of May 19, 1970

President Lee Herman presided; 19 members and 5 guests were present.

PROGRAM. **Collecting Plants and Animals in New Guinea.** Dr. Hobart Van Deusen of the American Museum of Natural History, told of the background the Archbold Expeditions to New Guinea which began in 1933. A color film, taken during the 7th expedition in 1964 showed the beautiful scenery of New Guinea, the methods of collecting and preparing botanical specimens and the capture and preparation of animal skins for the Museum's collection. Extra specimens were shared with other museums throughout the world. Dr. Van Deusen emphasized the fact that New Guinea is still in the early stages of exploration from a collector's point of view, and many years of work lie ahead.

Dr. Topoff announced that tonight's meeting was the last of the academic year and that we would resume our meetings in October.

The meeting was adjourned at 9:30 P.M.

DANIEL J. SULLIVAN, *S.J., Sec.*

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Neotropic *Stenus* from the Collections of the American Museum of Natural History, New York (Coleoptera: Staphylinidae)

VOLKER PUTHZ
LIMNOLOGISCHE FLUSS-STATION DES MAX-PLANCK-INSTITUTS FÜR LIMNOLOGIE,
6407 SCHLITZ/HESSEN, G.F.R.

RECEIVED FOR PUBLICATION AUGUST 28, 1970

Abstract: Seven new species from Neotropics are described and the male characteristics of *Stenus postnotatus* L. Benick are described for the first time.

Although nearly 300 species of *Stenus* are known from the Neotropic Region this seems to be less than half of the species actually represented on that large continent. Among the materials which were kindly sent to me from the American Museum of Natural History, New York, were seven new species which are described below.

All measurements are given in microns.

Stenus (s. str.) **quadriguttatus** n. sp.

This new species belongs to the *lateralis*-group, in which it is remarkable because of the presence of four orange-red spots on the elytra.

Black, shiny, each elytron with two orange-red spots, very coarsely and rugosely punctured, distinctly pubescent. Antennae brown, club blackish. Palpi with the first two segments yellow, the third a little infuscated. Legs reddish-brown, knees and tarsal segments infuscated. Labrum black, densely pubescent.

Length: 4,0–4,5 mm

HOLOTYPE: ♂ Colombia: Cundinamarca, Road Facatativá—Anolaima, 2.600 m, 15.vii.1967, P. & B. Wygodzinsky leg.;

PARATYPE: ♀ ibidem, Road Sibaté to Aguadita, 2.600 m, 5.vii.1967, P. & B. Wygodzinsky leg.; ♂—paratype: ibidem, Road Sibaté to Fusagasuga, 2.400 m, 31.viii.1969, P. & B. Wygodzinsky leg.

Head slightly narrower than elytra at shoulders, much narrower than the greatest width of elytra (850: 1050), concave front broad (average distance between eyes: 500), with two sharp longitudinal furrows, its median-portion much narrower than each of the side-portions (these distinctly elevated in posterior half), distinctly elevated but not extending to the level of inner eye-margins. Puncturation coarse and very dense, at places confluent, punctures different in strength, largest punctures distinctly larger than cross section of width of 3rd antennal segment, smallest punctures (on the posterior portion of the side-portions) nearly as large as section of 3rd antennal segment, interstices narrower than half

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Acknowlegment: Many thanks are due to Dr. Lee H. Herman, Jr. for the loan of that material and gift of paratypes.

NEW YORK ENTOMOLOGICAL SOCIETY, LXXIX: 2–14. March, 1971.

the diameter of a puncture, in extreme middle nearly as large as the punctures themselves, median-portion therefore shiny.

ANTENNAE: slender, when reflexed not extending to the posterior margin of pronotum, penultimate segments scarcely longer than broad.

PROTHORAX: as broad as long (720), broadest a little behind middle, sides towards anterior margin convex, towards posterior margin concavely narrowed, dorsal middle with a distinct but narrow longitudinal furrow, sides also with a small impression. Puncturation very coarse, dense, and confluent transversely in anterior and posterior third, interstices mostly smaller than half the diameter of a puncture.

ELYTRA: large, much broader than head (1050: 850), as long as broad, shoulders prominent, sides slightly divergent posteriorly, moderately restricted in posterior sixth, posterior margin moderately shallowly emarginated (sutural length: 870). Sutural and humeral impressions distinct but shallow. Each elytron with two orange-red spots: one in about the middle of posterior third, its diameter about as large as the length of the 3rd antennal segment, the second on the dorsal-lateral margin in posterior half, this one not visible from above, slightly larger than the dorsal spot and indistinctly separated from other side-coloration. Puncturation very coarse and rugose, not as deep as on pronotum, somewhat tortuous at inner spots.

ABDOMEN: distinctly narrowed posteriorly, basal furrows of first tergites moderately deep, 7th tergite with a distinct membranous fringe apically (the insect is winged). Lateral margination broad, paratergites anteriorly as broad as length of 2nd antennal segment, coarsely punctured. Puncturation throughout moderately fine and sparse, punctures about as large as basal section of 3rd antennal segment, interstices on the sides of tergites nearly as large as punctures themselves, sometimes larger at middle of tergites.

LEGS: moderately robust, posterior tarsi nearly as long as posterior tibiae, 1st segment slightly shorter than 2nd and 3rd together, distinctly longer than the last: 250-150-115-80-200; 4th segment simple.

The whole insect is shallowly reticulated.

MALE: Metasternum broadly semicircularly impressed, its middle very narrowly extremely finely and densely punctured, dull, the sides coarsely and moderately sparsely punctured, reticulated interstices shiny, posterior portion near metacoxae impunctate and without any reticulation.

Femora thicker than in ♀, curved, no tooth at trochanters, meso- and metatibiae with distinct apical spines. 5th and 6th sternite broadly shallowed in middle, punctured similar to sides. 7th sternite shallowed in posterior middle, very finely and densely punctured and pubescent, very broadly and shallowly emarginated at posterior margin. 8th sternite with a deep, triangular excision in posterior quarter. 9th sternite apicolaterally roundly produced and with about five teeth. 10th tergite broadly rounded at posterior margin.

The aedeagus is principally as in the related species, it is very similar to that of *S. vermicularis* Bck. (comp. fig. 1, Puthz 1968a), but the sides of the apical portion of the medianlobe are more concave.

FEMALE: 8th sternite in middle of posterior margin with a distinctly produced flap (about as in *S. trifidus* Bck.). Valvifera at posterior margin with 4–5 teeth. 10th tergite broadly rounded. No distinctly sclerotized spermatheca.

Stenus **quadriguttatus** n. sp. is the sister-species of *S. vermicularis* Bck., from which it can be distinguished by its 4 elytral spots and narrower head, from *S. solidus* Bck. also by its 4 elytral spots and the medianlobe, which has no large, strongly sclerotized spines internally but is uniformly set with many small tufts, from *S. pseudogutta* Puthz by its 4 elytral spots and the reticulated abdomen.

HOLOTYPE: American Museum of Natural History, New York,

PARATYPES: ibidem and in my collection.

Stenus (s. str.) **megelytratus** n. sp.

This species is very remarkable in its sexual dimorphism which is shown in the measurements of the elytra: in the male (fig. 1) these are extremely broad and long, in the female (fig. 2) much narrower and shorter. The following diagnosis describes the male-holotype of which all characters of the exoskeleton are the same as in the female except the proportions of the elytra.

Moderately shiny, black, each elytron with a very large yellowish-orange spot, coarsely and densely punctured, indistinctly pubescent. Antennae with the first two segments reddish-brown, the following segments yellow, the club infuscated. Palpi yellowish-red. Legs reddish-yellow, knees scarcely, tarsal segments distinctly infuscated. Labrum blackish-brown, moderately densely pubescent.

Length: 4,5–5,0 mm

HOLOTYPE: ♂ PARATYPE: ♀ Colombia: Cundinamarca, Road Sibaté to Aguadita, 2.600 m, 5.vii.1967, P. & B. Wygodzinsky leg.; 3 ♀♀-paratypes: ibidem, Road Sibaté to Fusagasuga, 2.400 m, 31.viii.1969, P. & B. Wygodzinsky leg.

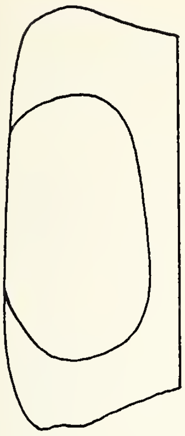
HEAD very small, much narrower than the elytra at shoulders (805: 880), front broad (average distance between eyes: 490), with two shallow longitudinal furrows, its median-portion distinctly a little narrower than each of the side-portions, shallowly elevated, extending to about the level of inner eye-margins. Puncturation moderately coarse and dense, diameter of a puncture a little smaller than cross section of width of 3rd antennal segment, interstices smaller than half the diameter of a puncture, large in middle of front.

ANTENNAE moderately slender, when reflexed extending to the posterior margin of pronotum (male), in the female they are shorter, 10th segment larger than 9th and 11th, penultimate segments distinctly but slightly longer than broad.

PROTHORAX distinctly longer than broad (720: 635), broadest near middle, sides towards anterior margin slightly convex, towards posterior margin concavely narrowed. Puncturation regular, coarse and dense, diameter or a puncture slightly or distinctly larger than section of 3rd antennal segment, interstices usually smaller than half the diameter of a puncture.

In the male the elytra are very large, much broader than head (1090: 805) and distinctly longer than broad (1210: 1090), in the female narrower than in male but still broader than head (1030: 870) and as long as broad. Shoulders prominent, sides posteriorly distinctly but not strongly straightly divergent, restricted in posterior sixth, posterior margin moderately deeply emarginated. Sutural and humeral impressions very shallow. Each elytron with a very large orange-red spot (fig. 1, 2). Puncturation slightly coarser than on pronotoum but sparser, interstices often half as large as half the diameter of punctures.

ABDOMEN in the male very slender, in the female broader, distinctly but not much narrowed posteriorly, basal furrows of first tergites deep, bases of tergites in middle with a distinct



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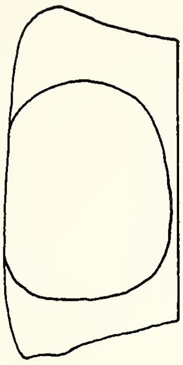

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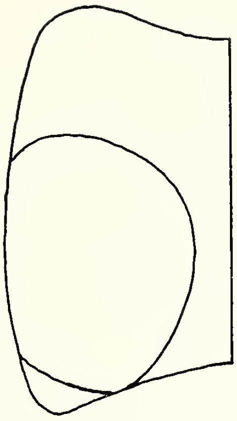

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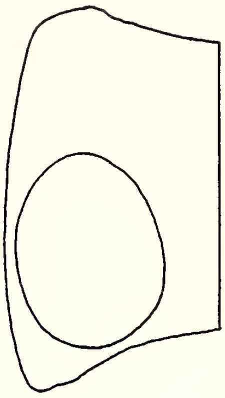

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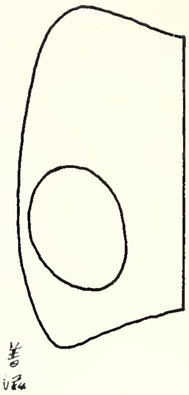

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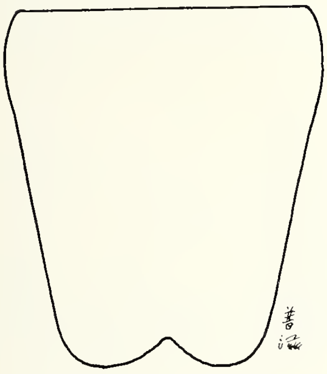

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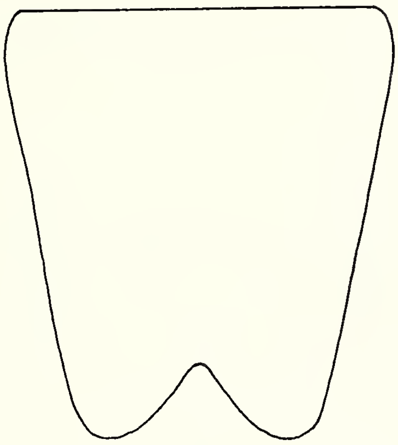

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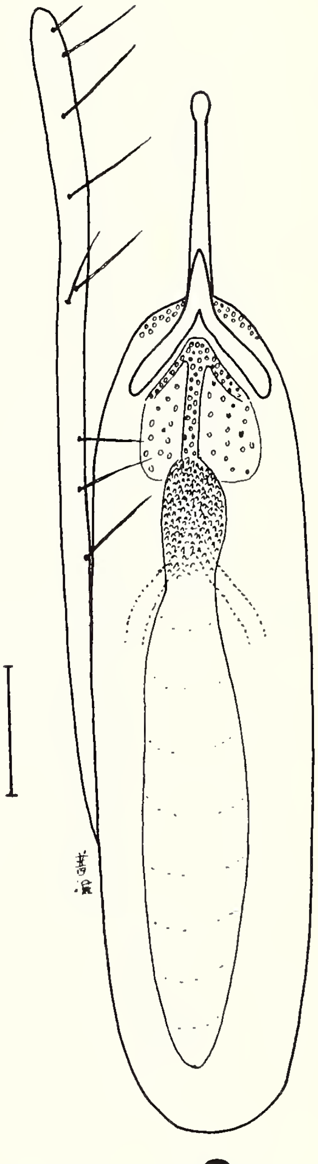

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cusp which is not as acute as in the species of the *hostilis*-group, more similar to those found in European *Parastenus*-species (*glacialis*-group). 7th tergite with a distinct membranous fringe apically. Lateral margination moderately strong, paratergites of first segments about as broad as 2nd antennal segment, with some punctures. Except the stronger puncturation of the basal furrows the puncturation of the tergites throughout is fine and sparse, denser on 6th and 7th tergite, diameter of a puncture about as large as basal section of 3rd antennal segment, interstices on tergites 3–5 nearly as large or (at places) larger than the punctures themselves, on 6th and 7th tergite slightly smaller.

LEGS slender, posterior tarsi about two thirds the length of the posterior tibiae, 1st segment about as long as the two following together, slightly longer than the last: 230-135-110-83-210; 4th segment simple.

The whole body is shallowly reticulated, distinctly on the last tergites (at 40×).

MALE: Metasternum impressed, regularly moderately coarsely and sparsely punctured. Legs lack special sexual characters. 6th sternite in posterior middle a little finer and denser punctured than on sides. 7th sternite shallowed in posterior middle, much finer and denser punctured and pubescent than on sides, posterior margin with a narrow and very shallow emargination. 8th sternite (fig. 6). 9th sternite apicolaterally produced and serrated. 10th tergite broadly rounded.

The aedeagus has a slender medianlobe which is triangularly accuminate into a narrow apex having some setae. Inside there are longitudinal expulsion bands and a membranous internal sac. Parameres slender extending well beyond the medianlobe, having numerous long setae at their ends.

FEMALE: 8th sternite broadly rounded. Valvifera apicolaterally produced with some teeth. 10th tergite rounded at posterior margin. No distinctly sclerotized spermatheca.

Stenus **megelytratus** n. sp. is distinguished from all neotropic species which have the abdomen margined and the tarsi simple by its very large elytral spot, the conspicuous sexual dimorphism and its sexual characters. I do not know its sister-species. Holotype in the American Museum of Natural History, New York, paratypes ibidem and in my collection.

Stenus (*Hypostenus*) **paraensis** n. sp.

This new *Hypostenus* is remarkable because of its broad head having a very broad, deeply concave front, and a dense and rough puncturation. I do not know any closely related species of *S.* **paraensis**; the new species should be regarded as the 1st representative of a group.

Nearly dull, black, regularly, coarsely, and very densely punctured, slightly pubescent. Antennae yellowish with the club a little infuscated. Palpi yellow. Legs reddish-yellow, knees and apices of tarsal segments distinctly but slightly infuscated. Labrum dark-brown, moderately densely pubescent.

Length: 4,5–5,0 mm

HOLOTYPE: ♂ Brazil: Pará, Jacaréacanga, xii.1968, M. Alvarenga leg.;

PARATYPE: ♂ (elytra lacking): Brazil (no further indication), coll. Sharp.

HEAD: distinctly broader than elytra (1050: 980), front very broad (average distance between eyes: 650), deeply concavely excavated with two very shallow, indistinct longitudinal furrows, median-portion distinctly narrower than each of the side-portions, indistinctly rounded. Puncturation coarse and very dense, diameter of a puncture about as large or larger than cross section of width of 3rd antennal segment, interstices smaller than half the diameter of a puncture. In the holotype only the small antennal tubercles are smooth, in the paratype the interstices of the punctures of the front's median-portion are very slightly larger than those on the sides, posteriorly distinctly larger.

ANTENNAE: moderately slender, when reflexed extending to about the posterior margin of the pronotum, penultimate segments distinctly longer than broad.

PROTHORAX: distinctly but not much longer than broad (880: 730), broadest behind middle, sides towards anterior margin convex, towards posterior margin concavely narrowed. No impressions. Puncturation coarse and extremely dense, somewhat rugose, diameter of a puncture about as large or a little larger than cross section of width of the 3rd antennal segment, interstices much smaller than half diameter of a puncture.

ELYTRA: distinctly narrower than head (980: 1050), about as long as broad, shoulders prominent, sides nearly parallel, restricted in posterior quarter, posterior margin deeply emarginated (sutural length: 690). Sutural and humeral impressions short but distinct. Puncturation throughout a little coarser but as dense as on pronotum.

ABDOMEN: cylindrical, slightly narrowed posteriorly, basal furrows of first segments deep, 7th tergite with a distinct membranous fringe apically (the insect is winged). Puncturation coarse and dense, on first tergites about as coarse as near the eyes, interstices smaller, as large as or distinctly larger (5th tergite) than half the diameter of punctures, finer on the last tergites, punctures of tergite 6 and 7 as large as basal section of 3rd antennal segment, interstices larger than half the diameter of a puncture, but distinctly smaller than punctures themselves. 10th tergite at posterior margin smooth and broadly rounded.

LEGS: moderately robust, posterior tarsi about as long as two thirds of the posterior tibiae, 1st segment distinctly longer than the 2nd and 3rd together and also longer than the last: 230-130-75-108-150; 4th segment deeply bilobed.

The head lacks reticulation, pronotum and elytra with distinct reticulation coming out of the puncture-holes, abdomen with a very shallow reticulation only on the last tergites, interstices of puncturation of tergites 3–6 smooth.

MALE: Legs lack special sexual characters. Fore-sternites coarsely and densely punctured. 5th sternite near posterior margin more sparsely punctured than on the sides. 6th sternite near posterior margin more sparsely and more finely punctured than on the sides. 7th sternite with a broad median impression in posterior half having very fine and extremely dense puncturation and pubescence, posterior margin broadly but shallowly emarginated. 8th sternite (fig. 7). 9th sternite apicolaterally produced into a moderately strong tooth, slightly serrated at apical sides, distinctly serrated in posterior middle.

The aedeagus (fig. 8) has a medianlobe which is in its anterior half split into a broad and weakly sclerotized ventral lobe and a strongly sclerotized, pin-like dorsal lobe. The ventral lobe is distinctly shorter than the dorsal and has a triangular expulsion clasp at its apex, the dorsal lobe is moderately curved dorsally at its apex, the apex slightly but distinctly enlarged like a button. Inside there are longitudinal expulsion bands, very small and dense tufts, and a broad internal sac. The slender parameres extend distinctly beyond the medianlobe having many setae on the whole inner sides.

Stenus **paraensis** n. sp. somewhat resembles *S. laticeps* Sharp but is distinguished by its much denser puncturation of head and elytra. *S. laticeps* might be the sister-species of **paraensis** (both are only known from Para), but an exact decision is not possible because the male of *laticeps* is not known at present.

HOLOTYPE: American Museum of Natural History, New York, PARATYPE: British Museum (Natural History), London.

Stenus (*Hypostenus*) **grisescens** n. sp.

This new species belongs to the *ariolus*-group and closely resembles *S. ariolus* Er. and *S. capillaceus* Bck.

Dull, black, the whole body densely clothed with a moderately short, grey pubescence, especially conspicuous on the abdomen, very coarsely and extremely densely punctured throughout (also the whole abdomen !). Antennae, palpi, and legs yellowish, knees indistinctly, apices of tarsal segments distinctly infuscated. Clypeus with an accumulation of grey hairs resembling a beard. Labrum dark-brown with a lighter apical margin.

Length: 5,0 mm

HOLOTYPE: ♀ Colombia: Cundinamarca, Finca San Pablo, 3 km N. of Alban, 1.800 m, 1.-12.viii.1967, P. & B. Wygodzinsky leg.

Head distinctly narrower than elytra (930: 1000), front broad (average distance between eyes: 570) and nearly completely flat, puncturation very coarse and dense, diameter of a puncture as large as the cross section of width of the 3rd antennal segment, interstices smaller than half the diameter of a puncture. Only the small antennal tubercles shiny.

ANTENNAE: moderately slender, when reflexed extending to about posterior margin of pronotum, penultimate segments distinctly but not much longer than broad.

PROTHORAX: much longer than broad (920: 715), broadest a little behind middle, sides towards anterior margin nearly straightly convergent, towards posterior margin very shallowly concavely narrowed. No impression. Puncturation throughout coarse and very dense, about like on head, but a little coarser.

ELYTRA: distinctly broader than head (1000: 930), longer than broad (1090: 1000), shoulders moderately prominent, sides nearly parallel, restricted in posterior quarter, posterior margin deeply emarginated (sutural length: 890). No distinct impressions. Puncturation throughout distinctly coarser than on pronotum but as dense, diameter of a puncture larger than section of the 2nd antennal segment.

ABDOMEN: cylindrical, moderately narrowed posteriorly, basal furrows of first segments deep, 7th tergite with a distinct membranous fringe apically (the insect is winged). Puncturation throughout coarse and extremely dense, on the first tergites about as coarse as on head, less coarse on the last tergites but as dense, diameter of a puncture of the 7th tergite as large as basal section of 3rd antennal segment. Only the 10th tergite more sparsely punctured.

LEGS: slender, posterior tarsi nearly two thirds as long as the posterior tibiae, 1st segment a little longer than the 2nd and 3rd together, also a little longer than the last segment: 240-115-110-120-185; 2nd segment slightly bilobed, 3rd and especially 4th segment deeply bilobed and broader than the first segments.

Tergite 7 has a shallow, tergite 8 a distinct reticulation, the rest of the body—also the 10th tergite—lack reticulation.

MALE: unknown.

FEMALE: 8th sternite broadly rounded. Valvifer with a distinct but very small and curved tooth at apical sides, a second minute tooth at apex internally. 10th tergite broadly rounded.

From both relatives, *S. ariolus* Er. and *S. capillaceus* Bck., the new species is distinguished by its much denser abdominal puncturation, from *ariolus* furthermore by its shorter pubescence of the elytral base and the bases of the tergites and the shorter antennae, from *capillaceus* by its narrower head and coarser and denser puncturation of the elytra.

HOLOTYPE: American Museum of Natural History, New York.

Stenus (*Parastenus*) **falcifer** n. sp.

This new species is remarkable because of its very large elytral spots (fig. 3) and its coarse and confluent puncturation.

Moderately shiny, black, each elytron with a very large orange spot (fig. 3), coarsely and rugosely punctured, moderately pubescent. Antennae brownish-yellow, club brown. Palpi yellowish, apex of 2nd and the 3rd segment infuscated. Legs light reddish-brown, knees and apices of tarsal segments infuscated. Labrum dark brown, moderately densely pubescent.

Length: 4,5–4,8 mm

HOLOTYPE: ♂ Colombia: Cundinamarca, Finca San Pablo, 3 km N. of Alban, 1.800 m, 1.12.viii.1967, P. & B. Wygodzinsky leg.

HEAD: distinctly narrower than elytra (1200: 1310), front narrow (average distance between eyes: 600) and deeply excavated, with two distinct longitudinal furrows which converge a little anteriorly, median-portion slightly narrower than each of the side-portions, strongly elevated but not extending to the level of inner eye-margins. Puncturation moderately coarse and dense, diameter of a puncture nearly as large as cross section of width of 3rd antennal segment, interstices smaller than half the diameter of a puncture. Median-portion of front posteriorly impunctate, shiny, small shiny areas also at antennal tubercles and near inner eye-margins posteriorly.

ANTENNAE: moderately slender, when reflexed well extending to posterior margin of pronotum, penultimate segments distinctly longer than broad.

PROTHORAX distinctly but slightly longer than broad (940: 885), broadest in about middle, sides towards anterior margin straightly convergent, towards posterior margin concavely narrowed. Surface with one indistinct longitudinal furrow in middle and distinct lateral impressions in middle and posterior half. Puncturation coarse, very dense, rugose, diameter of a puncture larger than section of 3rd antennal segment but smaller than section of the 2nd antennal segment, interstices smaller than half the diameter of a puncture.

ELYTRA distinctly broader than head (1310: 1200) broader than long (1310: 1200), shoulders prominent, sides distinctly but not strongly divergent posteriorly, restricted in posterior quarter, posterior margin deeply emarginated (sutural length: 950). Sutural and humeral impressions moderately deep. Each elytron with a very large orange spot in posterior two thirds extending to the epipleurae and laterally prolonged nearly to the shoulders, the spot also extends to the posterior margin of the elytra, but is well separated from the suture. Puncturation about as coarse as on pronotum but a little sparser, interstices sometimes as large as half the diameter of punctures, shiny.

ABDOMEN convex, moderately narrowed posteriorly, basal furrows of first tergites deep, 7th tergite with a distinct membranous fringe apically (the insect is winged). Sides narrowly margined, paratergites of first segments about as broad as the second antennal segment having very few punctures. Puncturation moderately coarse and moderately dense, on first three tergites about as coarse as on head, interstices laterally larger than half the diameter of the punctures but smaller than the punctures themselves, larger in middle, as large as or slightly larger than punctures. 7th tergite distinctly more finely punctured, diameter of a puncture smaller than basal section of 3rd antennal segment, interstices larger than the punctures.

LEGS robust, posterior tarsi about two thirds the length of posterior tibiae, 1st segment distinctly longer than the 2nd and 3rd together and than the last too: 340-145-95-160-245; 4th segment deeply bilobed.

Fore-parts lack reticulation, first tergites shallowly, last distinctly reticulated.

MALE: Metasternum broadly impressed, puncturation of the sides coarse and dense, that of middle and anterior portion extremely fine, shallow, and dense, shortly brushlike pubescent. Metatrochanters with a very long, slender, curved tooth, which is about as long as the 6th antennal segment ("**falcifer**"), meso- and metatibiae with a large tooth before apex. All sternites emarginated at posterior margin, the 3rd very shallowly, 4th–6th slightly deeper, 7th also very shallowly, 8th with a narrow, triangular excision in about posterior third (length of sternite: length of notch = 73: 22). Sternites 3–7 distinctly impressed in middle, distinctly finer and sparser punctured than on sides, puncturation of the middle of sternite 7 distinctly denser than that of the middle of sternite 6. 9th sternite apicolaterally produced and with some very fine teeth. 10th tergite at posterior margin smooth and rounded. The aedeagus has a slender medianlobe which is rounded at apex. Inside there are a lot of strongly sclerotized structures similar to those found in the basal portion of the medianlobe of *S. colosseus* Puthz (comp. fig. 21, PUTHZ 1968 b). Parameres as long as the medianlobe having many setae at their ends.

Stenus **falcifer** n. sp. (name derived from spine of metatrochanter) is distinguished from all other neotropic *Parastenus* by its very large elytral spot, its coarse and rugose sculpture, its length, and the sexual characters.

HOLOTYPE: American Museum of Natural History, New York.

Stenus (*Parastenus*) **gibbus** n. sp.

This new species resembles by its general facies species of the (*Stenus s. str.*) *lateralis*-group; amongst spotted species of *Parastenus* it resembles closest *S. centrimaculatus* Bck. from Costa Rica.

Dull, black, each elytron with an orange-yellowish spot in posterior half (fig. 5), very coarsely, roughly, and rugosely sculptured (except finer punctured abdomen), head and abdomen densely pubescent. Antennae yellowish-brown, darker towards apex, club brown. Palpi pale-yellow. Legs yellowish-brown, knees very broadly but not strongly infuscated, apices of tarsal segments (except of the 5th) brown. Labrum dark-brown, densely pubescent.

Length: 4,3–5,0 mm

HOLOTYPE: ♂ Colombia: Cundinamarca, Finca San Pablo, 3 km N. Alban, 1.800 m, 1.-12.viii.1967, P. & B. Wygodzinsky leg.;

PARATYPES: 1 ♂, 1 ♀ Cundinamarca, Finca Bella Vista near Sasaima, 28.v.1965, P. R. Craig leg.

HEAD: distinctly but not much narrower than elytra (1020: 1100), front moderately broad (average distance between eyes: 550) with two deep longitudinal furrows, median-portion about two thirds as broad as each of the side-portions, strongly elevated like a long callus, shiny or very sparsely punctured on sides and anteriorly, extending distinctly to the level of inner eye-margins. Puncturation moderately coarse and very dense, diameter of a puncture a little larger than basal section of 3rd antennal segment, not as large as largest section of that segment, interstices smaller than half the diameter of a puncture, larger on strongly elevated antennal tubercles and one small area near inner eye-margins posteriorly.

ANTENNAE: moderately slender, when reflexed distinctly extending beyond posterior margin of pronotum, penultimate segments nearly twice as long as broad.

PROTHORAX: slightly broader than long (790: 770), convex, broadest in about middle, sides towards anterior margin convex, towards posterior margin concavely narrowed. Numerous impressions on surface: a deep one in middle third, one transverse one near anterior margin, one lateral one in about middle, and a shallower transverse one near posterior margin. Puncturation very coarse, rough, and rugose, diameter of a puncture larger than section of 3rd antennal segment, smaller than that of the 2nd antennal segment, narrow interstices much smaller than half the diameter of a puncture, except in middle where the shiny interstices can become larger than the punctures (variability !).

ELYTRA: distinctly broader than head (1100: 1020), distinctly broader than long (1100: 960), shoulders prominent, sides a little divergent posteriorly, restricted in posterior quarter, posterior margin moderately deeply emarginated (sutural length: 730). Sutural impression narrow, humeral impression also narrow but a little deeper. Elytral spot as in fig. 5, the surrounding and the sides of elytra dark-brown, not as black as the rest of elytra. Puncturation yet coarse and stronger rugose than on pronotum, very dense.

ABDOMEN: convex, moderately narrowed posteriorly, basal furrows of first segments deep, 7th tergite with a distinct membranous fringe apically (the insect is winged). Lateral margination moderately broad, paratergites of first segments distinctly a little broader than the first antennal segment having many moderately coarse punctures. Basal puncturation of first tergites coarser than on head, puncturation of posterior two thirds about as on head but sparser in the middle. 5th and 6th tergite with distinctly finer and sparser puncturation, punctures about as large as one eye-facet, interstices on the sides smaller than the punctures themselves, in the middle a little larger. Puncturation of the 7th tergite a little stronger than that of the 6th.

LEGS: robust, posterior tarsi in male about four fifths as long as the posterior tibiae (in female about two thirds as long), first segment distinctly longer than 2nd and 3rd together, much longer than the last: 300-140-90-170-225; 4th segment very deeply bilobed.

The whole insect, also the 10th tergite, lack reticulation.

MALE: Metasternum broadly impressed, coarsely and very densely punctured on the sides, anteriorly extremely densely and finely punctulate and pubescent, near metacoxae coarsely and moderately sparsely punctured, interstices smooth. Metatrochanters with a distinct and sharp tooth which is shorter than the 8th antennal segment. Mesotibiae with a strong apical spine internally, metatibiae with a strong preapical tooth. 3rd to 6th sternite broadly but shallowly impressed in middle, a little finer punctured and longer pubescent than on the sides, posterior margins very shallowly emarginated, emargination of sternite 7 more distinct, a little deeper, puncturation before emargination much denser than on the first sternites, impression very shallow, nearly imperceptible. 8th sternite with a narrow, triangular notch in posterior third. 9th sternite apicolaterally produced and with some teeth. 10th tergite at posterior margin smooth and rounded.

The aedeagus has a slender medianlobe which becomes narrower towards apex. It is curved dorsally and has two dorso-lateral narrow carinae which are stronger sclerotized. Inside and at the anterior portion the medianlobe has structures similar to those found in *S. endoquameus* Puthz (comp. fig. 19, PUTHZ 1968 b) (expulsion-clasp and ananas-tufts), at posterior portion strongly sclerotized rounded teeth as in *S. colosseus* Puthz and *S.* **falcifer** n. sp. The slender parameres are distinctly shorter than the medianlobe, having numerous setae at their ends.

FEMALE: 8th sternite rounded at posterior margin, very slightly produced in middle. Valvifer with some teeth at rounded posterior margin. 10th tergite rounded.

Stenus gibbus n. sp. can be distinguished from *S. centrimaculatus* Bck. by other situation of its elytral spot and the sexual characters, from the other spotted *Parasteni* by its structure of the head.

HOLOTYPE and one PARATYPE: American Museum of Natural History, New York, one PARATYPE in my collection.

STENUS (PARASTENUS) POSTNOTATUS L. Benick, 1917

Stenus postnotatus L. Benick, 1917, Ent. Bl. **13:** 313 f.
Stenus postnotatus; L. Benick, 1938, Mitt. Münchn. Ent. Ges. **28:** 281

This species was described from one female (Colombia: Historaques, 6.000′, Terra templa). The male was found amongst material from the American Museum of Natural History, New York (compared with ♀-holotype): Colombia: Cundinamarca, Finca San Pablo, 3 km N. Alban, 1.800 m, 1.-12.viii.1967, P. & B. Wygodzinsky leg.

MALE: Metatrochanters with a distinct but very short spine, meso- and metatibiae with strong apical spines. Metasternum broadly but shallowly impressed, coarsely and very densely punctured and pubescent, extremely densely anteriorly. Puncturation of fore-sternites coarse and dense, interstices smooth, near posterior margin the puncturation of sternites 4–6 is scarcely sparser than on sides. 5th sternite at posterior margin very shallowly, nearly imperceptibly emarginated, posterior emargination of sternite 6 also shallow but distinct. 7th sternite shallowed in middle, slightly finer and distinctly denser punctured and pubescent than on sides, posterior margin extremely shallowly emarginated. 8th sternite with a narrow excision in about posterior third (length of sternite: length of notch = 57: 17). 9th sternite apicolaterally with a long tooth which is curved ventrally. 10th tergite very broadly rounded.

The aedeagus has a moderately slender medianlobe of which the apex is strongly curved dorsally. Inside there are longitudinal expulsion-bands, longitudinal membranous tufts apically (not ananas-tufts) and membranes set with fine transverse rugae (no teeth, no spines). Parameres slender, a little longer than the medianlobe, with many long setae at their ends.

Stenus (*Parastenus*) **cuzcoensis** n. sp.

This new species also belongs to the *Parastenus*-group which has an orange-yellowish spot on each elytron (fig. 4).

Shiny, black, each elytron with a large suboval orange-yellowish spot in posterior half (fig. 4), surrounded by a brownish area, coarsely and densely punctured, shortly pubescent. Antennae yellow, club slightly infuscated. Palpi yellowish. Legs reddish-yellow, knees and apices of tarsal segments a little infuscated. Labrum dark-brown with the anterior margin yellowish-brown.

Length: 5,5–5,8 mm

HOLOTYPE: ♀ Peru: Macchu Picchu Ruins, Cuzco, 9.500 feet, 21.ii.1947, J. C. Pallister leg.

HEAD: distinctly narrower than elytra (1105: 1230), front moderately broad (average distance between eyes: 650), moderately concave with two shallow but distinct longitudinal furrows, its median-portion about as broad as each of the side-portions, shallowly elevated and broadly rounded, not extending to the level of inner eye-margins. Puncturation coarse and dense, diameter of a puncture about as large as cross section of width of 3rd antennal segment, shiny interstices at most smaller than half the diameter of a puncture, posterior portion of the middle of front impunctate. Because of sparser puncturation very small, not very distinct shiny areas are found near antennal tubercles and posteriorly near inner eye-margins.

ANTENNAE: moderately robust, when reflexed not extending to the posterior margin of pronotum, penultimate segments distinctly a little longer than broad.

PROTHORAX: convex, nearly as broad as long (860: 900), broadest distinctly behind middle, sides towards anterior margin convex, towards posterior margin a little concavely narrowed. No impressions on surface. Puncturation coarse and dense, diameter of a puncture nearly as large as section of 2nd antennal segment, interstices at most smaller than half the diameter of a puncture, in posterior middle often as large or a little larger.

ELYTRA: distinctly broader than head (1230: 1105), slightly broader than long (1230: 1160), shoulders prominent, sides distinctly but not strongly divergent posteriorly, restricted in posterior quarter, posterior margin deeply emarginated (sutural length: 820). Dorsal impressions indistinct. Spot as in fig. 4, the surrounding, especially the sides of elytra brownish. Puncturation about as coarse as on pronotum but less deep and less dense, interstices as large as half the diameter of a puncture or (at places) larger.

ABDOMEN: broad and convex, slightly narrowed posteriorly, basal furrows of first tergites deep, 7th tergite with a distinct membranous fringe apically (the insect is winged). Lateral margination narrow, paratergites of first segments about as broad as the 2nd antennal segment, set with some strong punctures. Puncturation of the whole abdomen coarse and moderately dense, nearly as coarse as on front near inner margins of eyes, interstices larger than half the diameter of a puncture but less large than the punctures themselves.

LEGS: moderately robust, first segment of posterior tarsi longer than 2nd and 3rd segments together (rest lack in the holotype). 4th segment of tarsi deeply bilobed.

Head without any reticulation, pronotum anteriorly and posteriorly deeply reticulated, smooth in middle, elytra distinctly reticulated, the whole abdomen shallowly but distinctly reticulated.

MALE: unknown.

FEMALE: 8th sternite distinctly but not strongly produced in posterior middle. Valvifer with a long and slender tooth at apical sides which is distinctly curved towards the middle. 10th tergite narrowly rounded at posterior margin.

Stenus **cuzcoensis** n. sp. differs from *S. praecellens* Bernh. by its length, sparser puncturation of pronotum and elytra, and the sexual characters from

S. gibbus n. sp. and *S. centrimaculatus* Bck. by its less elevated middle-portion of front, sparser puncturation of the fore-parts, and its sexual characters.

HOLOTYPE: American Museum of Natural History, New York.

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Fleas from Windham County, Vermont (Siphonaptera)

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Abstract: Twelve species of fleas, representing 4 families, were collected from small mammals at Grout Pond, Windham County, Vermont during the summer of 1969. Species are listed with hosts, and number of males and females collected. No new records for Vermont are reported.

During the summer of 1969, small mammals were trapped at Grout Pond, Windham County, Vermont, to collect fleas. The elevation of Grout Pond is approximately 2,300 feet, and would be considered an intermediate height in Vermont. Surrounding the pond is a thick forest consisting of balsam fir, spruce, beech, birch, and maple.

All mammals were trapped in either regular mouse or rat snap traps baited with peanut butter. Twenty-five traps were set out just before dusk at places most likely to catch animals (under trees where evidence of feeding was observed, openings in ground from runways or burrows, under fallen trees, and in runways through grass). The traps were visited between 7:00–8:00 A.M. If there was no evidence of activity, the traps were moved. If some of the traps were snapped, or if an animal was caught, the traps were reset and visited every three hours during the day. Trapped animals were placed in glass jars to which an ether-soaked tissue was added. Most fleas came to the surface of the fur and died. They were removed with forceps, and transferred to 70% alcohol. The dead animal was then combed for any fleas still present.

Since many fleas are more closely associated with a certain type of nest, rather than the animal itself, nests of the red squirrel, meadow mouse, and deermouse were examined. The nesting material was teased apart after being placed in a white enamel pan eight inches deep. Fleas were easily transferred to 70% alcohol by the use of a dissecting needle dipped in alcohol. All fleas were later mounted on microscope slides according to the technique of Holland (1949).

A total of 151 fleas, representing 4 families, and 12 species was collected. No species was found that had not already been reported from Vermont.

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Family Pulicidae

Ctenocephalides felis felis (Bouché)
August 15, ex dog (*Canis familiaris*), 3 ♂, 2 ♀.

Although called the cat flea, it is the flea common on dogs as well as cats in the northeast.

Family Hystrichopsyllidae

Hystrichopsylla tahavuana Jordan
August 8, ex meadow mouse (*Microtus pennsylvanicus*), 1 ♂.

This flea is not often collected, and is usually collected from moles. Fuller (1943) has only one record of a single ♀ from New Hampshire, while Osgood (1964) lists one ♂ and one ♀ from Vermont.

Stenoponia americana (Baker)
August 6, ex meadow mouse; 1 ♂, 2 ♀.

This flea is associated with low elevations, so this record might represent the upper limit of this species. It does not appear to be host-specific, and can be found on many small mammals.

Ctenophthalmus pseudagyrtes pseudagyrtes Baker
July 12, ex short-tailed shrew (*Blarina brevicauda*), 1 ♀; July 21, ex short-tailed shrew, 1 ♀, and ex meadow mouse, 1 ♀; July 23, ex northeastern chipmunk (*Tamias striatus*), 1 ♂; August 6, ex meadow mouse, 2 ♂; August 8, ex meadow mouse, 3 ♀.

Usually considered a non-specific flea, but in a survey of the literature, and unpublished collections (Benton and Kelly, 1969), moles and deermice are suspected to be the primary and secondary hosts respectively. This species, along with *Orchopeas leucopus*, usually represents the largest number of specimens in collections made in the northeast. Perhaps the small number collected in this study is due to the elevation, and may represent the upper limit of the species. It is well known that host alone does not determine where a flea may be found. This emphasizes the importance of studying the ecology of flea distribution as collections are made.

Doratopsylla blarinae Fox
July 18, ex short-tailed shrew, 3 ♂, 3 ♀.

Host-specific to the short-tailed shrew. Only rarely is it found on another mammal.

Family Ceratophyllidae

Megabothris acerbus (Jordan)
July 23, ex northeastern chipmunk, 1 ♂, 1 ♀.

Host-specific to the chipmunk. Osgood (1964) reports this flea from the red squirrel, the red-backed mouse, and the deermouse. These hosts should be considered accidental for this flea.

Megabothris asio asio (Baker)
August 7, ex meadow mouse, 1 ♀.

Considered a nest flea of the meadow mouse, it is rarely taken from the host proper. This particular specimen had a very deep sinus in sternite VII, which is an extreme variation (Benton, 1969, per. com.).

Megabothris quirini (Rothschild)
July 29, ex red-backed mouse (*Clethrionomys gapperi*), 1 ♀; July 31, ex deermouse (*Peromyscus leucopus*), 2 ♀; August 8, ex meadow mouse, 1 ♂; August 15, ex red-backed mouse, 1 ♀.

This flea has been recorded 9 times from New England: six from Vermont (Osgood, 1964), two from New Hampshire (Fuller, 1943), and one from Maine (Fox, 1940). Benton and Cerwonka (1960) believe its rarity indicates it is a nest flea. Also they associate this flea with the red-backed mouse. The flea has been reported from many small mammals ecologically associated with the red-backed mouse.

Monopsyllus vison (Baker)
July 19, ex red squirrel (*Tamiasciurus hudsonicus*), 5 ♂, 4 ♀; July 23, ex northeastern chipmunk, 1 ♂; July 26, ex red squirrel, 2 ♀; August 3, ex red squirrel, 3 ♂, 3 ♀.

Although this flea is host-specific to the red squirrel, it was not found in either of two red squirrel nests examined.

Orchopeas caedens durus (Jordan)
July 9, ex nest of red squirrel, 13 ♂, 7 ♀; July 19, ex red squirrel, 2 ♀; August 3, ex red squirrel, 2 ♂, 2 ♀; August 15, ex nest of red squirrel, 9 ♂, 14 ♀.

This flea is host-specific to the red squirrel, but is not found throughout the range of the animal. In New York State it has been collected only in the Adirondack Mountains and the Tug Hill Plateau. Elsewhere in New York it is replaced by *Orchopeas howardii*. This represents the largest published collection of this flea in Vermont, and emphasizes the need of examining nests. The two nests examined were crawling with this flea, and the collection was a small sample of the actual number present.

Orchopeas leucopus (Baker)
July 9, ex deermouse, 2 ♂, 4 ♀; July 12, ex deermouse, 6 ♂, 5 ♀; July 21, ex deermouse, 1 ♂, 3 ♀; July 22, ex deermouse, 5 ♂, 5 ♀; July 31, ex deer-

mouse, 2 ♂, 2 ♀; August 2, ex deermouse, 4 ♂, 4 ♀; August 13, ex deermouse, 2 ♂.

It is host-specific to the genus *Peromyscus* (deermice), but can be found on its predators, and ecologically associated animals. An abundant flea.

Family Leptopsyllidae

Peromyscopsylla catatina (Jordan)
July 27, ex red-backed mouse, 1 ♂; August 11, ex red-backed mouse, 1 ♀; August 14, ex red-backed mouse, 4 ♀; August 15, ex red-backed mouse, 1 ♀.

This flea is thought to be host-specific to the red-backed mouse. While other small mammals may serve as the host for this flea, it is never found outside the range of the red-backed mouse.

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Scanning Electron Microscopy of Antennal Structures of Five Haematopinus (Anoplura: Haematopinidae)

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Abstract: Scanning electron microscopy is used to demonstrate the possible use of antennae of Anoplura for taxonomic purposes. Of the five *Haematopinus* studied there are sensilla coeloconica, one on the distal posterior aspect of the fourth, and one on the posterior aspect of the fifth antennal segments. There are two pore organs that appear associated with the sensilla coeloconica of the fifth segment. The sizes of the atria of the sensilla coeloconica and the location and distinctness of the pore organs are found to vary considerably and thus may be of taxonomic significance.

Scanning electron microscopy has been used by Miller (1969, 1970 a, b) Hinton et al. (1969) and Hayes et al. (1967) for studies of the surface of insects at both low and high magnifications to give greater depth of field than possible with light microscopy. Specimen preparation is easy and results in little or no demonstrable distortion of surface morphology. Thus minute surface organs of insects may be studied. Such detailed studies may lead to better understanding of phylogeny and physiology of these organisms.

The procedure for studying representatives of the Order Anoplura requires clearing of the specimens in a 10% solution of caustic potash (KOH) until the soft body contents are completely liquified. While rendering the sclerotized plates and genitalia more distinct, this usually causes collapse and distortion of the membranes and other less sclerotized areas. The dissolving technique is often considered the most effective method for lice (Hopkins, 1949). The procedure enables the recovery of the total parasite fauna. However, the resulting specimens are of little value for study of the minute surface details with the Scanning Electron Microscope (S.E.M.). Thus, for studies with the S.E.M. either brushing or searching techniques are required.

Studies with the S.E.M. are limited to the surface structures since it is not capable of penetrating the thinnest membrane. Although topographical views of ultra-

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structure are shown in greater detail the genitalia are not as visible. This may lead to difficulties in classification if observations are limited to the S.E.M.

One of the problems in working with the Anoplura is the lack of available material. For studies with the S.E.M. it is practical to develop taxonomic procedures using surface structures instead of the internal organs. The antennae and their sensilla are here proposed to supplement the internal structures currently used in taxonomy.

Miller (1969, 1970 a, b) using the S.E.M. demonstrated that the antennal sensilla, particularly those of the fourth and fifth or terminal segments, vary considerably among the families of Anoplura studied. The present S.E.M. study of five species of *Haematopinus* was made to determine whether or not variations in antennal sensilla and their integument is evident among species.

MATERIALS AND METHODS

One hundred-twenty specimens were examined! Twelve specimens of *Haematopinus asini* (Linn.) furnished by W. L. Jellison of Parke-Davis Memorial Library, Hamilton, Montana; 12 specimens of *H. asini* furnished by J. S. Dunlap of Washington State University; 12 specimens of *H. eurysternus* (Nitzsch), furnished by Ke Chung Kim of Pennsylvania State University; 24 specimens of *H. eurysternus* (Nitzsch), furnished by W. P. Meleney of U.S.D.A., Albuquerque, New Mexico; 24 specimens of *H. quadripertusus* Fahrenholz also furnished by W. P. Meleney; 12 specimens of *H. suis* (Linn.) furnished by J. S. Dunlap; 12 specimens of *H. suis* (Linn.) furnished by E. M. Nevill of the Department of Agricultural Technical Services, Republic of South Africa; 12 specimens of *H. tuberculatus* (Burmeister) furnished by R. E. Lewis of Iowa State University.

Six adult males and six females were examined from each lot except for *H. eurysternus* furnished by W. P. Meleney, where 12 nymphal stages were also examined, and with *H. quadripertusus* where four males, sixteen females and four nymphs were examined. The *H. suis* furnished by E. M. Nevill were cleared specimens upon receipt. All the specimens were received in either 70% alcohol or alcohol/glycerin. They were washed in fresh 70% ethyl alcohol prior to being mounted. The specimens were cemented to the specimen stubs using aluminum paint. Four specimens of each sex from each lot were cemented dorsal side up and the remaining specimens were cemented ventral side up. The nymphs were cemented dorsal side up except for two from each lot which were placed ventral side up. They were then air dried and coated with approximately 200 angstroms of gold in a vacuum evaporation chamber and studied with a Cambridge Steroscan Mark II S.E.M. at 20 kV. Each louse was completely examined by S.E.M. prior to the studies of the antennal structures. The specimens are on file at the Parasitology Section, Department of Pathology and Laboratories of Nassau County Medical Center, East Meadow, New York.

HAEMATOPINUS ASINI (LINN.)

The morphological characteristics of the fourth and fifth antennal segments of the 12 specimens studied are similar. The opening of the sensillum coeloconicum of the fourth antennal segment is located near the distal apex of the segment on the posterior aspect. This opening is slightly oval and measures approximately 4 by 6 microns. It is surrounded by 4 to 6 concentric rings that appear to be formed by the cuticle of the segment (Fig. 1). The opening of the sensillum coeloconicum of the fifth or terminal antennal segment is located slightly posterior to the center of the segment on its posterior aspect. This opening measures 4 to 5 microns in diameter. There are two pore organs located anteriorly and on opposite sides of the sensillum (Fig. 2). These pore organs each measure approximately 4 to 5 microns in diameter. There are numerous concentric rings (5 to 7) originating from around the sensillum. There are no separate rings around the individual pore organs, thus the organs are not distinct.

The entire antenna appears strongly sclerotized and smooth except for the fifth segment. The texture of this segment particularly that distal to the sensillum coeloconicum is slightly squamate.

HAEMATOPINUS EURYSTERNUS (NITZSCH)

The morphological characteristics of the fourth and fifth antennal segments of the 24 adults studied are similar. The 12 nymphs examined exhibited fusing of the two terminal segments, leading to an elongated fourth terminal segment. However, the sensilla coeloconica, pore organs, and setae appear in the proximal areas where they normally occur in the adult stages, the texture of the segment, although not as strongly sclerotized as in the adults, is similar to them.

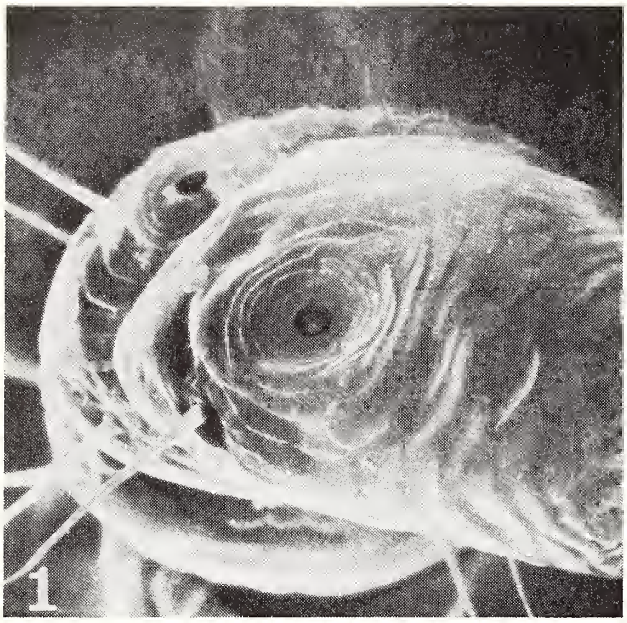
The opening of the sensillum coeloconicum of the fourth antennal segment is located near the distal apex of the segment on the posterior aspect. This opening is slightly oval and measures approximately 4 by 6 microns. It is surrounded by concentric rings and is relatively indistinguishable from that found on the fourth antennal segment of *H. asini* previously described.

The opening of the sensillum coeloconicum on the fifth or terminal antennal segment is located on the proximal quarter of the segment. The opening measures approximately 6 to 7 microns in diameter. It is surrounded by several (3–5) concentric rings that appear to be formed by the cuticle of the segment. Just anterior to the sensilla are two pore organs (Figs. 3–4) which each measure approximately 6 microns in diameter. Their two pore organs are very distinct and each is surrounded by its own concentric rings. There is a fusion of these rings where they meet giving the appearance of a plate. The integument of the antennae is generally smooth except for the rudimentary ridges noted distal to the sensilla coeloconica.

HAEMATOPINUS QUADRIPERTUSUS (FAHRENHOLZ)

The morphological characteristics of the fourth and fifth antennal segments of the 20 adults studied are similar. The 4 nymphs examined showed fusion of the two terminal segments, leading to an elongated fourth terminal segment. However, the sensilla coeloconica, pore organs, and setae appear in the proximal areas where they normally occur in the adult stages. The texture of the segment although not as strongly sclerotized as that of the adults is similar.

The opening of the sensillum coeloconicum of the fourth antennal segment is located near the distal apex of the segment of the posterior aspect. This opening is slightly oval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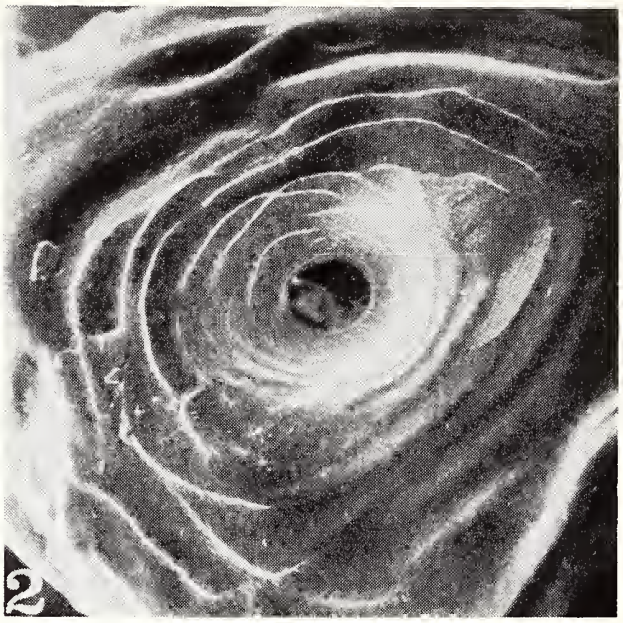
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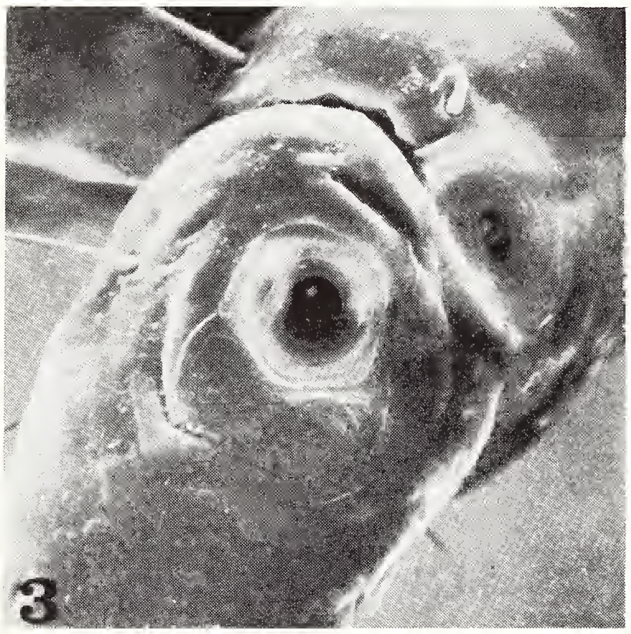
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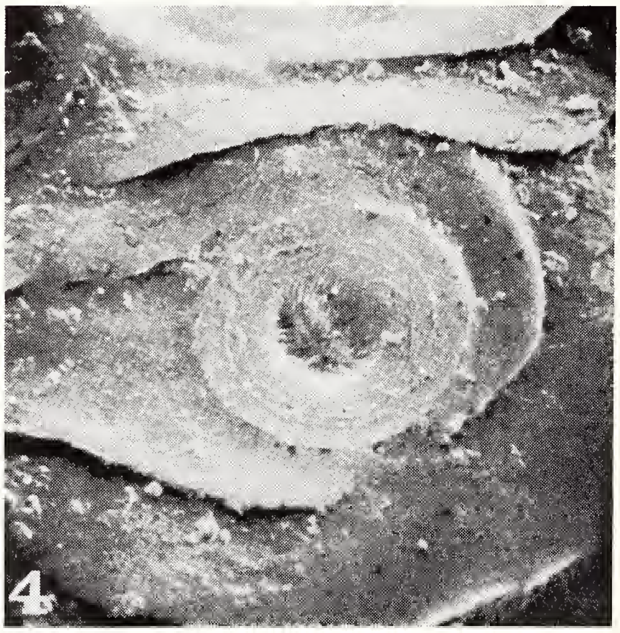
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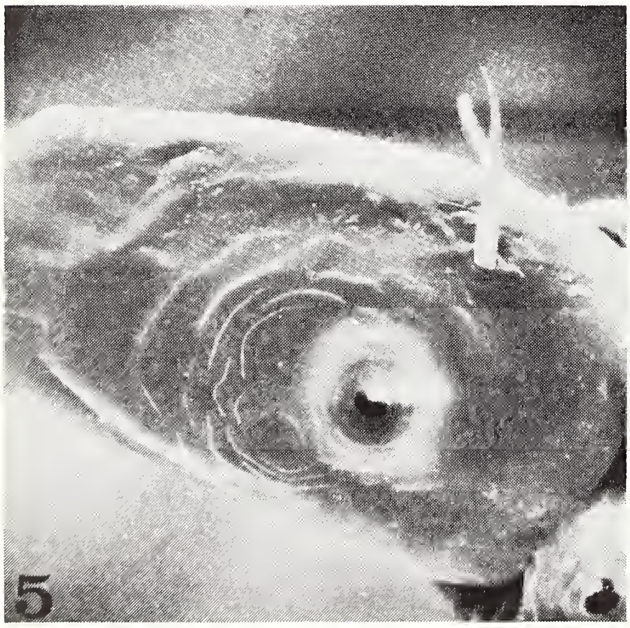
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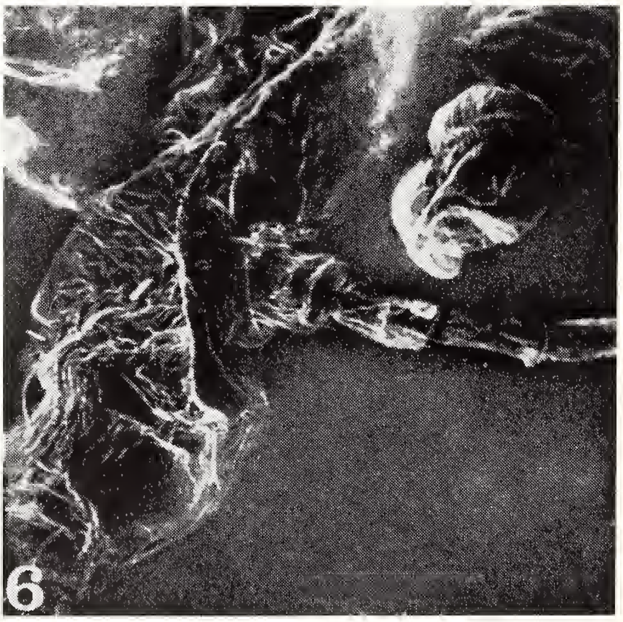
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and measures approximately 3 by 5 microns. It is surrounded by concentric rings and is relatively indistinguishable from those previously described.

The opening of the sensillum coeloconicum on the fifth or terminal antennal segment is located on the proximal quarter of the segment (Fig. 5). The opening measures approximately 3 to 4 microns in diameter. It is surrounded by several concentric rings that appear to be formed by the cuticle of the segment. Just anterior to the sensilla are two pore organs which each measure approximately 6 microns in diameter. The two pore organs are very distinct and each is surrounded by its own concentric rings. There are rings common to both pore organs and the sensilla coeloconicum, however, no plate effect is evident. The integument of the antennae is generally smooth except for the rings around the sensillum coeloconicum and pore organs.

HAEMATOPINUS SUIS (LINN.)

The morphological characteristics of the fourth and fifth antennal segments of the 12 cleared specimens varied considerably. This variation is primarily in the degree of collapsing and folding of the integument. This distortion is best shown by comparing the head of the cleared specimen (Fig. 6) with a similar view of an uncleared specimen (Fig. 7).

The morphological characteristics of the fourth and fifth antennal segments of the 12 uncleared adults studies are similar. The opening of the sensillum coeloconicum of the fourth antennal segment is located near the distal apex of the segment on the posterior aspect. This opening measures 1.5 to 2.5 microns in diameter (Fig. 8). It is surounded by concentric rings faintly outlined in the cuticle.

The opening of the sensillum coeloconicum of the fifth or terminal antennal segment is located close to the center of the segment on the posterior aspect. The opening measures approximately 1.5 to 2.5 microns in diameter. It is surrounded by several concentric rings. The integument of the antennae is generally smooth except for the rings around the sensilla coeloconica and pore organs. There are faint lines evident on the fifth segment distal the pore organs.

HAEMATOPINUS TUBERCULATUS (BURMEISTER)

The morphological characteristics of the fourth and fifth antennal segment of the 12 specimens studied are similar. The opening of the sensillum coeloconicum of the fourth antennal segment is located near the distal apex of the segment on the posterior aspect. This opening is slightly oval and measures approximately 4 by 6 microns. It is surrounded by concentric rings of the cuticle.

The opening of the sensillum coeloconium of the fifth of terminal antennal segment is

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Fig. 1. Sensilla coeloconica of fourth and fifth antennal segments of *Haematopinus asini.* 1,000×.

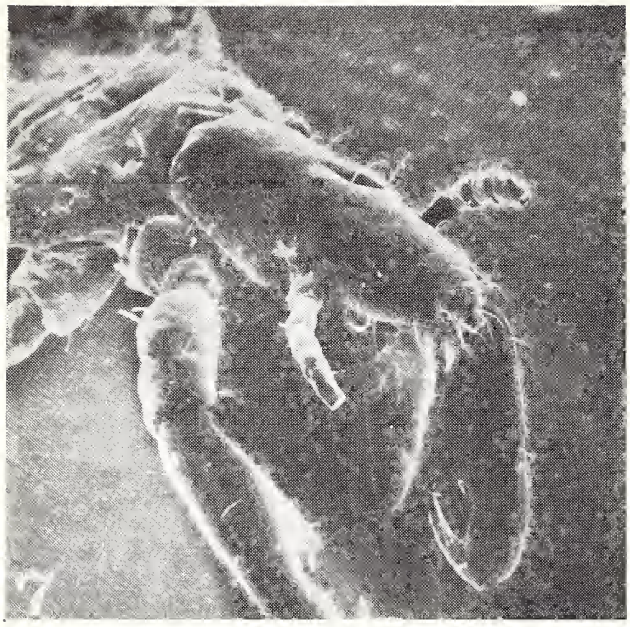
Fig. 2. Sensillum coeloconicum and pore organs of fifth antennal segments of *H. asini.* 2,200×.

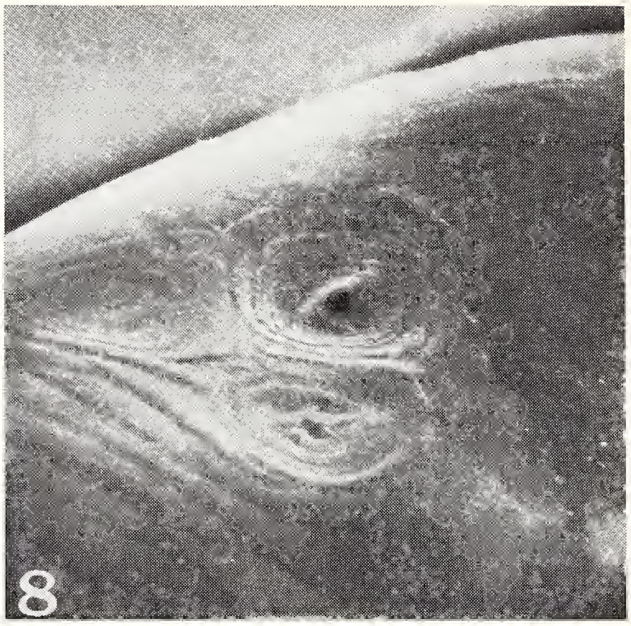
Fig. 3. Sensillum coeloconicum and pore organs on fourth and fifth antennal segments of *H. eurysternus.* 1,000×.

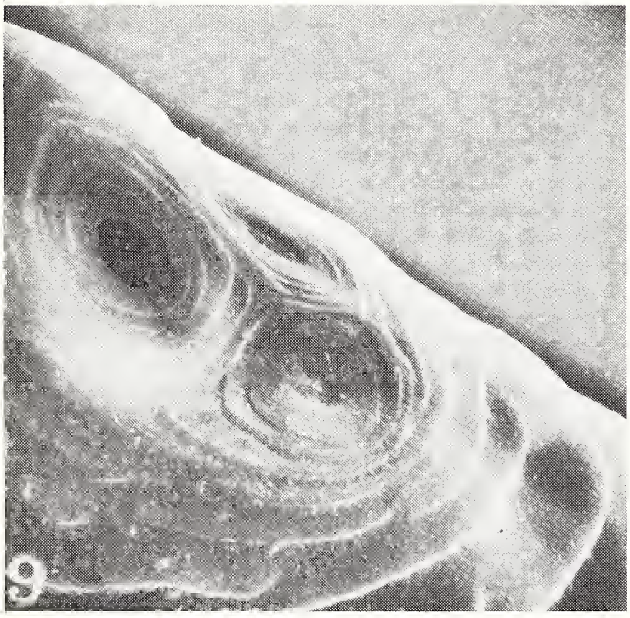
Fig. 4. Pore organ on fifth antennal segment of *H. eurysternus.* 5,500×.

Fig. 5. Sensillum coeloconicum and pore organs on fifth antennal segment of *H. quadripertusus.* 1,000×.

Fig. 6. Head and antenna of female *H. suis* that had been cleared prior to examination. 160×.







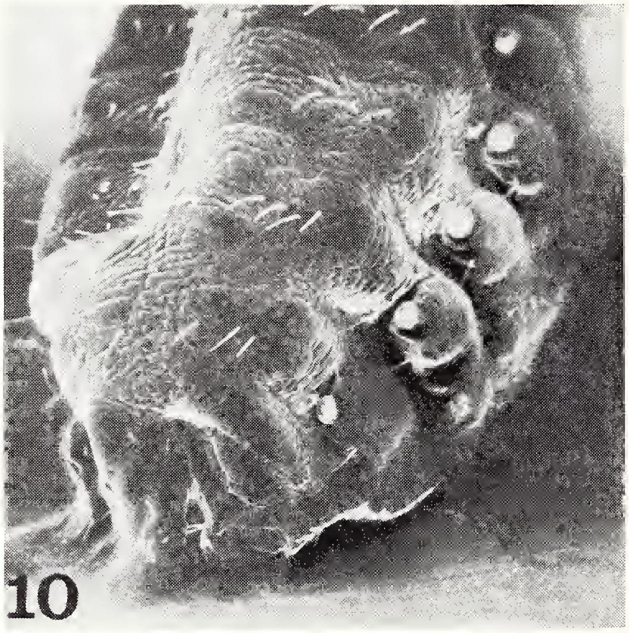


Fig. 7. Head and antenna of female *H. suis* uncleared. 50×.

Fig. 8. Sensillum coeloconicum of fifth antennal segment of *H. suis*. 2,000×.

Fig. 9. Sensillum coeloconicum and pore organs on fifth antennal segment of *H. tuberculatus*. 2,000×.

Fig. 10. Paratergal and tergal plates and genital plates seen on segments 3 through 9 of *H. eurysternus*. 80×.

located on the proximal quarter of the segment (Fig. 9). This opening measures 3 to 4 microns in diameter. Just anterior to the sensillum are two organs which each measure approximately 6 microns in diameter. The two pore organs are surrounded by their own concentric rings, rings common to both, and also rings common to the sensillum coeloconium. However, the pore organs are not as distinct as seen in *H. eurysternus*. The integument of the antennae is generally smooth except for the fifth segment where starting at the region of the sensillum coeloconicum and extending to the apex of the segment there are numerous ridges and a somewhat squamous appearance is noted.

Table 1

Species of *Haematopinus*	Sensilla coeloconica 4th Antennal Segment Sizes in Microns	Sensilla coeloconica 5th Antennal Segment Sizes in Microns	Pore Organs Size Microns	Location in relation to Sensilla coeloconica & distinctness
H. asini	4 by 6 oval	4–5	4–5	on sides of indistinct
H. eurysternus	4 by 6 oval	6–7	6	anterior to distinct
H. quadripertusus	3–5 round	3–4	6	anterior distinct
H. suis	1.5–2.5 round	1.5–2.5	5–6	anterior distinct
H. tuberculatus	4 by 6 oval	3–4	6	anterior somewhat indistinct

DISCUSSION

Differentiation between *Haematopinus quadripertusus* and *H. eurysternus* has been demonstrated by using the S.E.M. Ferris (1951) states that although *H. quadripertusus* from cattle in tropical countries is generally much larger, no morphological differences could be detected between it and *H. eurysternus*. However, Stojanovich and Pratt (1966) in their pictorial keys differentiate the two as distinct species. Separation is based upon the more acute and longer median projections of the thoracic sternal plate of *H. quadripertusus* as well as the presence of only four setae on the male genital plate as opposed to the six found on *H. eurysternus*. These differences were also shown by W. P. Meleney (1969). Examination of the antennae indicated differences in the sizes of the openings of the sensilla coeloconica and the texture of the integument in the areas or region of the pore organs, indicating that they represent two distinct species.

Examination of the antennae of the five species revealed differences (Table 1) in the size of the openings, location and variation in distinctness of the pore organ, and differences in the texture of the integument of the distal portion of the fifth or terminal segment. By combining these features with the size and shape of various plates and number of setae it should be possible to determine the species of Anoplura without use of the internal structures. The antennal morphological characteristics of the adults were also present in the nymph stages examined. Previous studies (Miller 1970a) showed that even when there is sexual dimorphism of the antennae that the number of setae, sizes of pore organs and openings of the sensilla coeloconica did not seem to vary. Studies are continuing in an attempt to develop taxonomic keys for the Anoplura based on the antennal characteristics and surface morphology using the S.E.M.

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Range Extension for the European Skipper, *Thymelicus lineola*, in the Northeast (Lepidoptera: Hesperiidae)

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Abstract: The European skipper has greatly expanded its range on the Allegheny Plateau in central New York, east to Chenango County. The first record from the Pocono Plateau in Pennsylvania is reported. Populations on the Piedmont in Bucks County, Pa. and Mercer County, New Jersey reached outbreak proportions in 1970. The skipper's range is expected to become continuous across the northeastern United States.

Burns (1966) reported the current status of the European Skipper, *Thymelicus lineola* (Ochsenheimer) in North America. At that time it was disjunctly distributed: around the Great Lakes and on the Piedmont from Connecticut to Maryland and in British Columbia. The intervening Appalachian and Allegheny Plateau provinces have now been colonized, and the distribution of *T. lineola* is rapidly approaching continuity across the Northeast (fig. 1). The range has also expanded in Pennsylvania and New Jersey, and population outbreaks similar to those in southern Ontario (Arthur, 1962; Pengelly, 1961) have been found there. These new records are grouped by states below.

NEW YORK. Burns (1966) reports only the Niagara Frontier localities given by Clench (1957). The European Skipper has been present in the Erie-Cattaraugus County area for several years (J. G. Franclemont, pers. comm.). In 1967 two specimens were received at Cornell from Fillmore, Allegany Co. On 28 June 1968 one specimen was taken along the Lehigh Valley Railroad tracks at Ithaca, Tompkins Co. and on 2 and 7 July 1968 several more were taken or seen in a hayfield at Ellis Hollow, 4 miles east of Ithaca. On 13 July 1968 one was taken at Montezuma, Seneca Co., and on 16 July one in the Town of Alabama, Genesee Co. No collecting was done in 1969.

In 1970 *T. lineola* was general and locally abundant in central New York. A systematic survey of hayfields in five counties was made on 24 June. Collections were made at East Richford, Tioga Co. (density at least 50/acre); De Ruyter and 3.7 mi W. Georgetown, Madison Co.; East Homer and 3.2 mi.

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[2] **Acknowledgments:** Dr. L. L. Pechuman, Mr. James Erickson, and Mr. Frank Slansky all provided specimens and confirmed field localities in upstate New York. Mrs. Adrienne R. Shapiro and Miss Valerie J. Austin did likewise in Pennsylvania and New Jersey.

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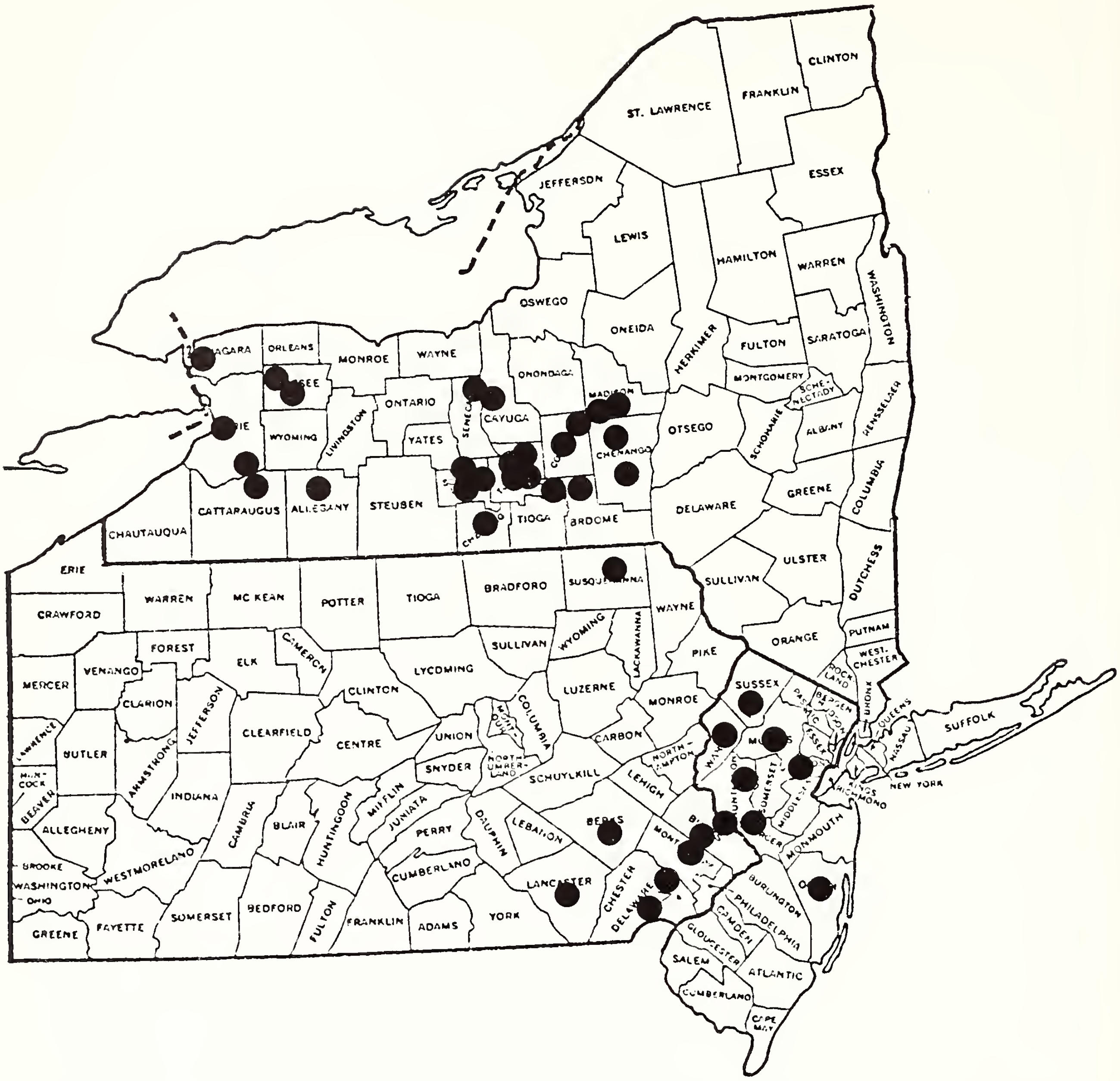

Fig. 1. Distribution of the European Skipper, *Thymelicus lineola*, in New York, New Jersey, and Pennsylvania.

S. De Ruyter, Cortland Co.; Triangle, Broome Co.; and ½ mi. S. Norwich, Chenango Co. (at east 50/acre). On 25 June further collections were made in several sites near Aurora, Cayuga Co. In Schuyler Co. collections were made at Mecklenburg (28 June), Texas Hollow (1 July), and the Blueberry Patch Recreation Area, vic. Logan (1 July) (density greater than 100/acre). Other 1970 collections were at Harris Hill, Chemung Co. (2 July) and the Tonawanda Indian Reservation, Genesee Co. (10 June). In Tompkins Co. the European Skipper was widespread (Cayuga Inlet Valley, Ithaca City Dump and downtown, Cornell University campus, Ludlowville, Ellis Hollow, Mount Pleasant, Turkey Hill, South Lansing, West Danby, Connecticut Hill), 9 June–10 July. Most of these sites were collected thoroughly in 1968, and no trace of *T. lineola* was seen then. This includes the Blueberry Patch site. No sign of the skipper was found in Onondaga, Oneida, or Lewis Cos. on 7 July, 1970.

PENNSYLVANIA. The first Piedmont record was in Lancaster Co., 1953 (Ehle, 1958), but no significant natural expansion seems to have occurred from this site although an artificial colony was started from it in Berks County. The skipper probably re-invaded Pennsylvania from New Jersey about 1966. Schweitzer (1968) found it at Chalfont, Bucks Co. and in 1969 (Schweitzer, in litt.) at the Waterloo Mills Field Research Station, Devon, Chester Co. and Longwood Gardens, also Chester Co. I collected these sites for several years through 1966 without seeing it. Boscoe and Curtis (1970) found it at North Wales, Montgomery Co. On 13 June 1970 I found *lineola* the commonest butterfly at New Hope, Bucks Co. and elsewhere in Solebury Township, with local densities of 500–1000/acre in hayfields. It was not present in southwest Philadelphia on waste ground on 11 June.

On 14 June 1970 it was the commonest butterfly at Harford, Susquehanna Co., in a hayfield along Route 81. This is the first record from the Pocono Plateau.

NEW JERSEY. *T. lineola* has been recorded from Hunterdon, Union, Sussex, Morris, and Ocean Cos. (Burns, 1966) and Essex Co. (May, 1968) so it was hardly surprising to find it at Hopewell, Mercer Co., on 12 June 1970. Its numbers were, however, surprising. It flew by hundreds of thousands, far outnumbering all other butterflies combined, crowding every flower and covering roadside puddles. Dead *lineola* lined the roads, and specimens were seen in every flower garden and shop window. The white form was not observed.

Three *lineola* were seen (one taken) in a vacant lot 3.5 mi. N. Buttzville, Warren Co., 14 June.

Specimens from these collections have been deposited in Cornell University.

DISCUSSION

The European Skipper has not yet been reported from the Catskills or southeastern New York, but must be present in Orange and Rockland Counties via expansion from the south, and may be widespread in at least the western Catskills. The source of the exploding populations in central New York is difficut to interpret. *T. lineola* has been in western New York for many years but expanded its range very slowly. It appeared in Tompkins Co. before Schuyler, so it probably did not spread directly eastward across the state. Although it was found at Montezuma in 1968 it is still uncommon and spotty around the north end of Cayuga Lake. It is possible that the colonization occurred at least in part from the aggressive New Jersey population, perhaps via the Pennsylvania Turnpike and Interstate 81. The Harford, Pa. record supports this interpretation. Whatever the source, there is reason to suspect that winter survival of the eggs may have been abetted by the heavy snow pack which in

1969–70 covered central New York nearly the entire winter; this external agency may have permitted the population to reach an adult density of outbreak proportions and to insure the establishment of the species throughout the area. If the western New York, central New York, and New Jersey ranges are not yet confluent, they can be expected to become so within a few years.

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Observations on the Biology of the Giant Palm-Boring Beetle, *Dinapate wrighti* Horn (Coleoptera: Bostrichidae)

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Abstract: Laboratory and field studies were made on the biology of *Dinapate wrighti* Horn, from the Colorado Desert of southern California. Grubs were studied and collected in both well-known and remote palm oases of the California fan palm, *Washingtonia filifera*, in the area of Palm Springs, California, and in Borrego Desert State Park, California. Five hundred fifty-seven specimens were reared and studied under artificial conditions.

Since its discovery by W. G. Wright (1886), and the erecting of a new genus in which to place the species by Horn, the giant (33 to 51 mm.) palm-boring beetle, *Dinapate wrighti* Horn, has been collected but little intensive study has been devoted to this highly specialized desert insect. Horn, in the original paper describes both adults and larva in detail. Since then, several papers have appeared, primarily in rare technical works. Comstock (1922) summarizes the early papers and describes the grub and pupa. Most of the work consisted of collecting palm trunk sections, rearing from the grubs, and observing under artificial conditions. Other than this it has been difficult to do more than hypothesize on the biology and life history of the beetle, since it is nocturnal and lives most of its life within the palms, both as a grub and an adult.

In September, 1960, I made a field trip to the southwest desert (Colorado Desert) of California with Mr. W. G. Abbott to Thousand Palms, a privately owned grove of several hundred fan palms, *Washingtonia filifera.* The owner called our attention to some fallen palms which had lain for several years. Some were riddled with the large exit holes of *Dinapate.* We cut a section of palm trunk about five feet long and twelve inches in diameter and came upon several grubs. The section was transported to the museum insectary. During the months of July and August, 1962, eight beetles—three males and five females—emerged. All were placed in a ten-gallon terrarium with some fresh palm cuttings, where they remained for the most part beneath the cuttings away from light. I was hopeful that they might copulate; but the males showed no

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interest in the females and upon contact they fought with the females as well as with other males. No feeding took place and within ten days all died.

On a subsequent trip to the same grove, the owner told us that occasionally the beetles were found clinging to his front porch screen, apparently attracted to the light. Martin (1917) states that all beetles he observed shunned light. In ten years of working with this species in the insectary, I found them repelled by light in every instance. Since they are apparently blind, it is my conclusion that in their swift and bumbling flight, they must have struck the wire screen and been injured. All attempts at collecting them by black light during their hatching season (June through September) were unsuccessful. Lloyd Tevis, director of the U.C. research station at Deep Canyon, Palm Desert, California (pers. comm.), reports that entomologists working at the research station had the same experience. Opposing my supposition is information that two entomologists from the agriculture department in Riverside, California, have collected the adults with black light, at least on two occasions. Their statement, which I heard "second-hand," was that when there was no moon or wind, the beetles came to light. I have been unable to verify this; but I have used black light under similar climatic conditions without success.

For years it was believed, with good reason, that *Dinapate* was host-specific on the fan palm, *W. filifera.* My investigations support this, and I believe now that they oviposit only in this species of palm. Davis (1940) and Fisher (1950) mention that the beetle has attacked date palms in the Coachella Valley. Elmer, of the University of California citrus research center and agricultural experiment station at Riverside, California, reports that the beetles have attacked California fan palms in the foothills of the Coachella Valley and occasionally have been found in an isolated date palm in that area, but not in date palms on the valley floor. Stickney, Barnes and Simmons also report that *D. wrighti* has damaged date palms in the Palm Springs area, but not those in the commercial date gardens in the valley. Stickney (1928–29) reports that the damage he observed was caused mainly by the feeding of adults. Davis (1928) commenting on the damage to transplanted palms (*W. filifera*) in Palm Springs, California, states that about 90 per cent of these trees were injured by the beetles burrowing down into the crowns and also that most of the large palms transplanted thirty to forty years ago showed the effects of beetle damage. An accumulation of excelsior-like frass near the growing tips of the trees is evidence of the presence of *D. wrighti.* Elmer (pers. comm.) reported finding the beetle in *Washingtonia robusta* at the Dunlap Nursery, Thermal, California. I investigated this nursery on the invitation of Mr. Phillip E. Mee, representative, and through his cooperation and the help of some of his gardeners examined damage to eight *W. robusta* which had been marked by Dr. Elmer. This damage, I concluded, was from feeding, since it was different from the attacks on the *W. filifera*. The damage I saw in the *robusta* was for the most part confined to long, deep furrows in the leaf stems and near the crown. A check with the Dunlap Nursery two years later revealed that no more damage had been found in the *W. robusta*. I concluded that this damage was done by beetles from a flight searching for *W. filifera*.

According to Palm Springs residents, the "main flight of the beetles occurs about July 1–15, although some beetles were active as early as June 15th and as late as August." These "flights" in all probability are movements of males from a brood searching for a new stand of palms where mating can take place with females from a different brood, or an exodus of a brood of both males and females caused by heavy competition.

In *W. filifera*, I have never seen "furrowing" damage, although it may occur from feeding. The females make definite entrances and tunnel to the bases of the crown, where, on the two trees sectioned, I have found as many as seven females in what might be termed a "communal" chamber. Upon reaching this area, especially in young palms, the base of the crown is completely eaten away and the leaves may easily be lifted out. This chamber is partly filled with a soft, thick, moist material which is composed of sap, chewed fibers and fecal matter. The beetles (females) were partly submerged, and I thought they were dead. When prodded however, they moved.

Although I did not find eggs or young grubs in a microscopic examination of samples of this bottom material, I feel that this must be where oviposition takes place. I base this upon the small size of the eggs (1.75 mm. by .90 mm. average) and the almost microscopic size of the newly hatched grubs. My failure to find newly hatched grubs may have been because they had moved down into the network of fine fibers at the bottom of the "chamber." Hubbard (1897) writes, in reference to the newly hatched grubs, that he found some of their borings under the fibers of the leaf bases, where they were not "larger than a friction match." I believe these borings must have been made by something other than *Dinapate* grubs. Because of their extremely small size, it seems unlikely that they can make an entrance to any part of the tough fibrous palms. If so, the entrance would be smaller than a friction match. I believe that the newly hatched grubs first feed on the soft, moist material in the "communal" chamber. By the time their mandibles are capable of attacking the softest fibers (at the base of the crown), they are probably at the bottom of the chamber, where they can begin boring down the bole of the palm.

The borings of the females occur at the axes of the leaf stems, and those of the grubs within the tree bole, where they may "powder" the portion directly below the crown. The grubs usually pack their tunnels behind them with frass.

In older palms thirty to fifty feet high that have recently been attacked by *D. wrighti*, exit holes of the adults were found to be concentrated in areas some eight to twelve feet below the crown. In older palms that have nurtured many broods, exit holes sometimes appear from the top portion to near the base of the bole. The palm shown in the photograph was literally pulverized with exit holes from top to bottom (Fig. 1). Probably the only reason it remained upright was that the hard-packed tunnels of the grubs strengthened it; the frass is so tightly packed that as it dries and hardens it becomes part of the palm, fusing with the fibers like plastic wood. Pupal chambers of adults are constructed within an inch or so from the outer surface and therefore have little effect in weakening the palm. It is only within a few feet below the crown that the borings of the developing grubs pulverize the palm seriously enough to cause eventual collapse of that section.

In respect to ovipositing, Davis, says, "It seems probable that the eggs may be laid in the burrows in the bud, as well as under the fibers of the leaf bases, as described by Hubbard, since in most of the fallen logs that have been seen by me, the portion near the crown was reduced to coarse powder, while the part farther down remained fairly solid." I have found no evidence to substantiate the hypothesis that the eggs are laid anywhere externally on the palms.

In observing the activities of *Dinapate* over a period of ten years during their hatching season, both at night and during the day, my observations have been as follows. Emergence of the adults always occurred nocturnally, although a very small opening may have been made during daylight hours. When final emergence took place, the beetles were fully hardened and darkened in color. Immediately they were free of the exit holes, they crawled aimlessly over the palm log, then took wing and alighted on the heavy netting spread over the logs around one end of the forty-foot insectary. The netting also covered two living young palms, *W. filifera*, about six to eight feet in height, with the leaf fans intact.

Over a period of time some 150 beetles were captured and marked with phosphorescent paint so that their activities could be observed in the dark. Large numbers painted on the elytra (odd numbers for females, even for males) were easily visible at close quarters. Although many of them congregated in the southeast corner, no mating activity was observed, but much fighting went on. Males and females, when confined together in a jar, soon lost a leg or two in combat. Twenty-seven beetles emerged from the first group of palm trunk sections. Eleven soon moved to the palm trees and began crawling over the trunks. There were seven females and four males. The females began burrowing at the bases of the leaf stems and during the night all disappeared into the tree, leaving small piles of frass at the openings of the burrows. Males then came to these burrows and tried to enter.

While the burrow was still shallow, the females would work for a time, then back out. Several times I observed them evacuating a drop of heavy liquid from the anus. As the burrow deepened, they deposited these drops here and

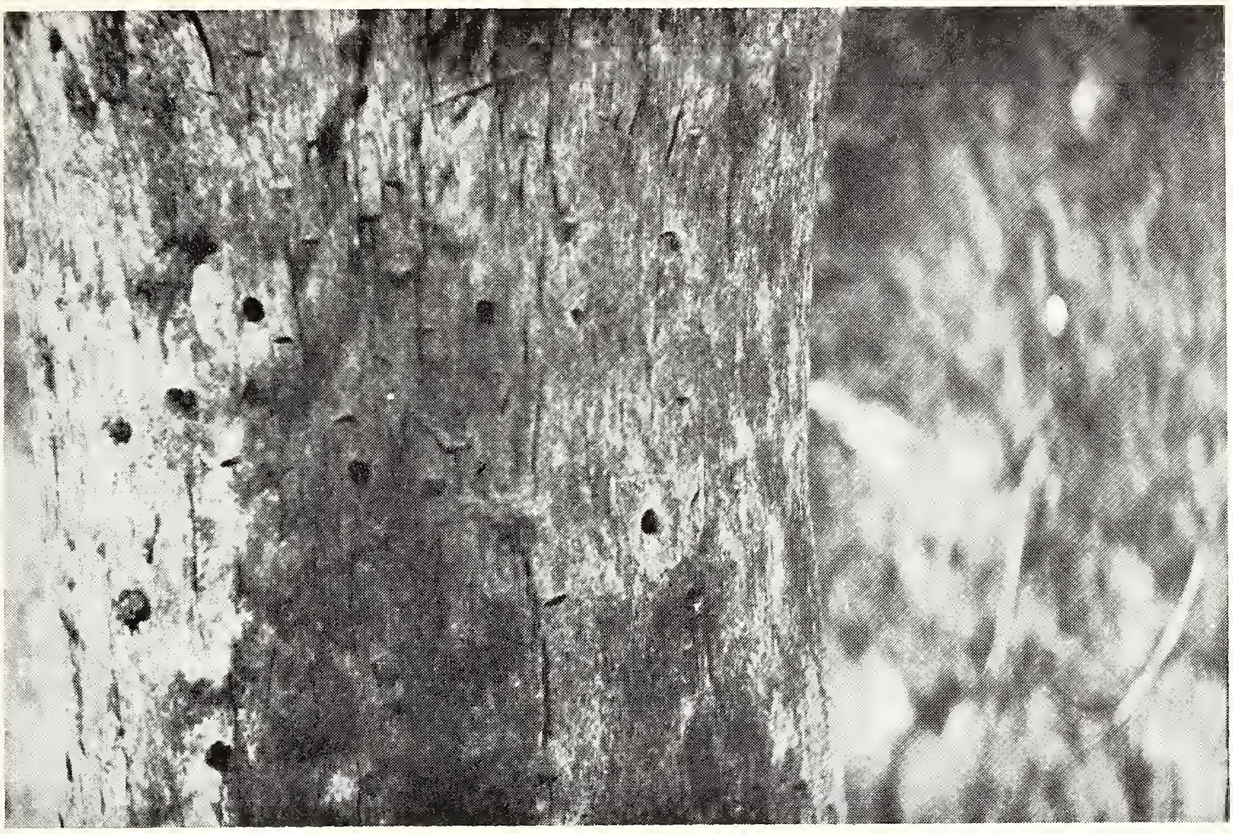

Fig. 1. Exit holes made by adult beetles.

there along the sides of the tunnel. Upon investigation under the microscope, the drops I examined proved to be a heavy glue-like liquid, which adhered strongly to the walls of the burrow. No ova were found in them.

The behavior of *Dinapate* is similar to that of the Shot-hole Borer, *Scolytus rugulosus* Ratz. According to Smith (1932) females of the latter cut circular holes in bark and construct tunnels into the beginning of the wood, then work up and down the limb through the inner bark and cambium. They lay their eggs along the sides of the tunnel, then embed them in shredded bark and wood. While boring the tunnel, each female is usually accompanied by a male. The males of *D. wrighti* also attend females who have begun tunneling into the palms. Sometimes several males collected about the tunnel entrance of a female, and as the tunnel deepened, they became very active and followed the female into the tunnel. There were audible sounds of fighting within, and some males would back out missing a leg or two, or with chunks bitten out of their elytra. The only time I have seen the males interested in the females was when the latter began making their tunnels. This leads me to believe that mating takes place within the tree.

The eggs probably hatch within a few days to a week after having been deposited in the soft material at the bottom of the chamber made by the females at the base of the crown. It is an ideal incubation chamber in which the young grubs can develop.

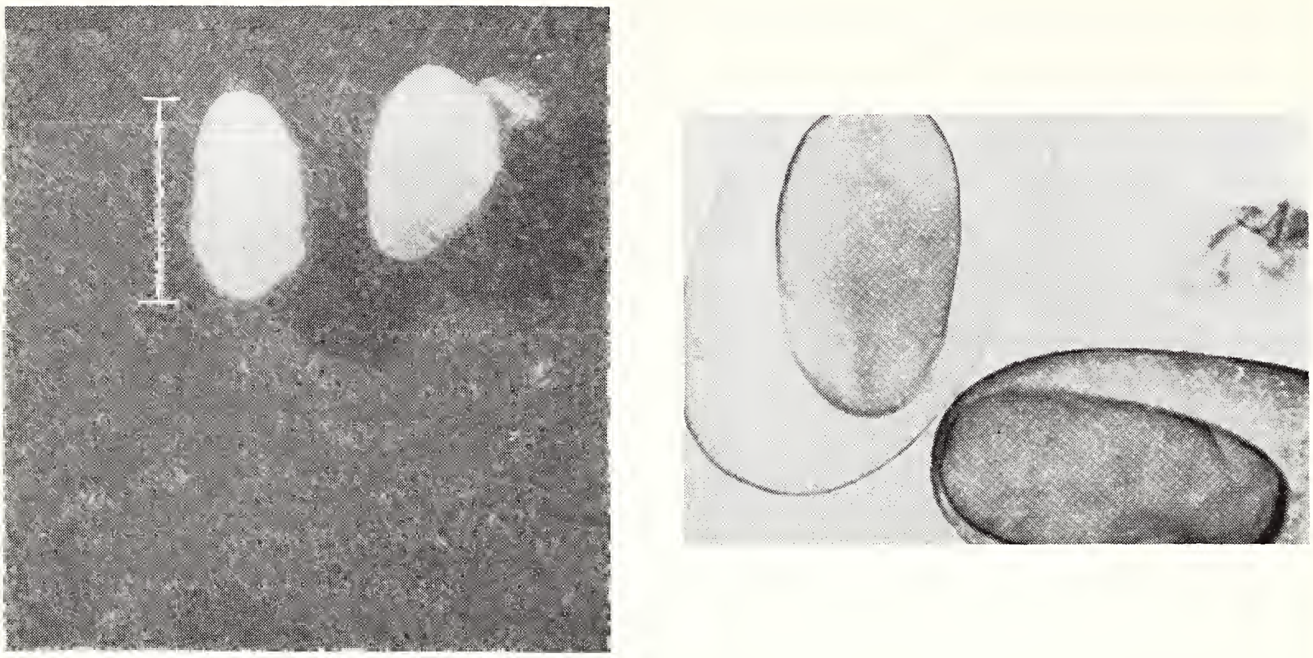

FIG. 2. Obovate eggs (left) which when cleared (right) in clove oil become transparent and show the embryo.

Davis (1940) states that the egg of *D. wrighti* has never been described and that in females cut when opening palm logs, no eggs were found in the ovaries. Two females that I kept separately in jars oviposited, and I was able to examine the eggs. The egg of *Dinapate* is obovate, averaging 1.75 mm. in length and .90 mm. in width. The outer surface is a moist, soft, yellowish-white capsule, fairly smooth and opaque. When cleared in clove oil it becomes transparent and the embryo can be seen (Fig. 2). Only two of the dead females dissected were found to contain ova.

A total of 557 beetles were reared in the insectary from palm sections taken at three oases in Thousand Palms Canyon, California. There were 381 females and 176 males. Males varied in size between 48 mm. to 52 mm. and females from 38 mm. to 43 mm. (Fig. 3). These variations probably result from climatic

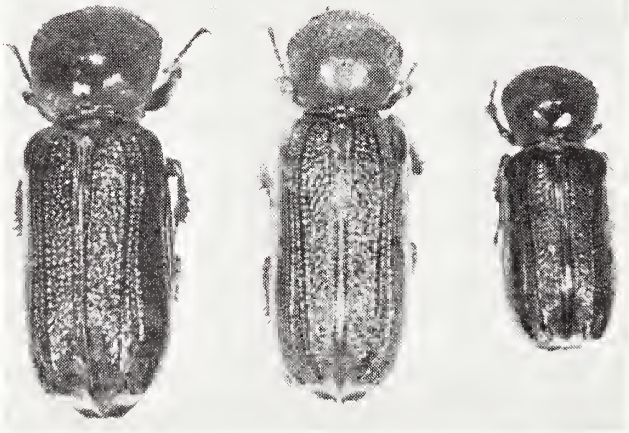

FIG. 3. Left: ♂ of normal size: center: ♀ of normal size and right: ♀ of small size.

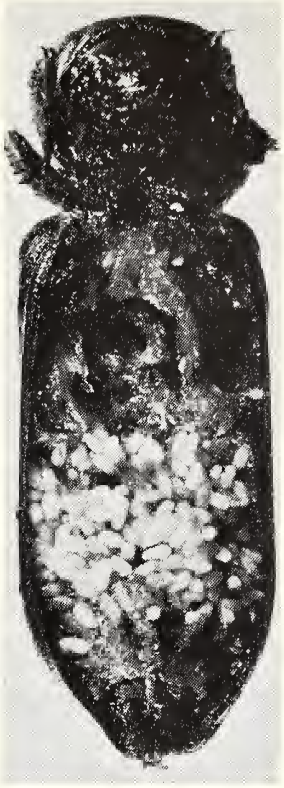

Fig. 4. Dissection showing mass of eggs in abdominal cavity.

conditions and the amount of food consumed by the grub. I found 29 females which were much smaller than normal—from 28 mm. to 35 mm. They were duller and a few had a definite reddish-brown color. The "norms" were dark polished brown. Only two of the dead females dissected contained ova. Four hundred forty-five eggs were counted in the smaller one (Fig. 4) and the one of "normal" size contained only 154 eggs. In the latter, much of the abdominal cavity was taken up by a large, obovate proventriculus. Dissection revealed two sclerotized structures, almost filling the proventriculus, in a position indicating that they moved one upon the other to grind the palm fibers. The inner wall of the proventriculus was heavily denticled by small blunt, slightly curved "teeth."

The proventriculus of the smaller female was narrower and elongate. The inner wall was denticled, and attached to one side was an elongate dark section, shaped somewhat like a radula which was hard and packed with rows of tooth-like structures which were an integral part of the wall. Morphologically the females appear identical; but the great difference in the proventriculi leads me to think that there may be two forms. Unfortunately I have not yet had time to carry this work farther or to examine the proventriculi of the males, and I must await the emergence of more adults.

The mass of eggs in each female was completely enveloped in a stringy, web-like net, which apparently holds them together. Examination under the microscope showed this stringy material to be similar to spider webbing. The abdominal cavity contained a large amount of whitish fatty substance. A single gland, lying ventrally below the egg mass in the abdomen, was discovered. Tubules of varying sizes extended from it, apparently open and not attached to any other organs. Since no other similar gland was found, it could be the source of the web-like material binding the eggs together. This is hypothetical, and additional work needs to be done to determine the function of this gland.

Since *D. wrighti* cannot be studied under its natural conditions without considerable expense and time-consuming effort, it may be some time before its biology and life history are completely known. Under artificial conditions, the adults after emergence live only a week or two. I have had eggs from two living females; but all efforts to culture them failed. They may not have been fertile.

The exact period of development from egg to adult is unknown. Campbell (1923), from his observations of beetles reared in his laboratory, suggests that this period may be from three to five years. At the moment, I concur. However, I have a young *W. filifera* in the insectary covered by a wire screen cage in which twelve females made their tunnels in 1966. To date (November, 1970), no beetles have emerged. This would indicate that the life history may be more than three years. It would be unwise to do more than hypothesize here, since the beetles were reared under artificial conditions in an area where the climate varies radically.

DISTRIBUTION

Wherever the oases of the California fan palm, *W. filifera,* were investigated, either the presence of *D. wrighti* Horn was discovered, or evidence of their presence was noted. Even in the Badlands of Borrego Desert State Park in southern California, where occasional small stands of palms—from one to several in a group—were found, there was evidence of the beetle. The palms here are widely scattered in a vast area of arid terrain consisting of many low tors and deep washes. I have yet to investigate sections in this area where oases have been seen from an airplane, but are difficult of access on foot. Michelbacher and Ross (1939) verified Hubbard's conjecture that the beetles were found as far south in Lower California as Catavina, some 300 miles south of Palm Springs, California. Nelson (1921) noted the presence of *Washingtonia* fan palms as far south as the lowlands and mountains of Sinaloa and southern Sonora on the mainland of Mexico, but made no mention of the beetles. In correspondence with Professor J. N. Mathieu, of the Instituto Technologico y de Estudios Superiores de Monterrey, Monterrey, N.L., Mexico, he explained that *Washingtonia* fan palms were not endemic to this area, but were planted as ornamentals. He found no evidence of the beetles. This is understandable, since *D. wrighti* is known to occur only in arid regions at lower altitudes.

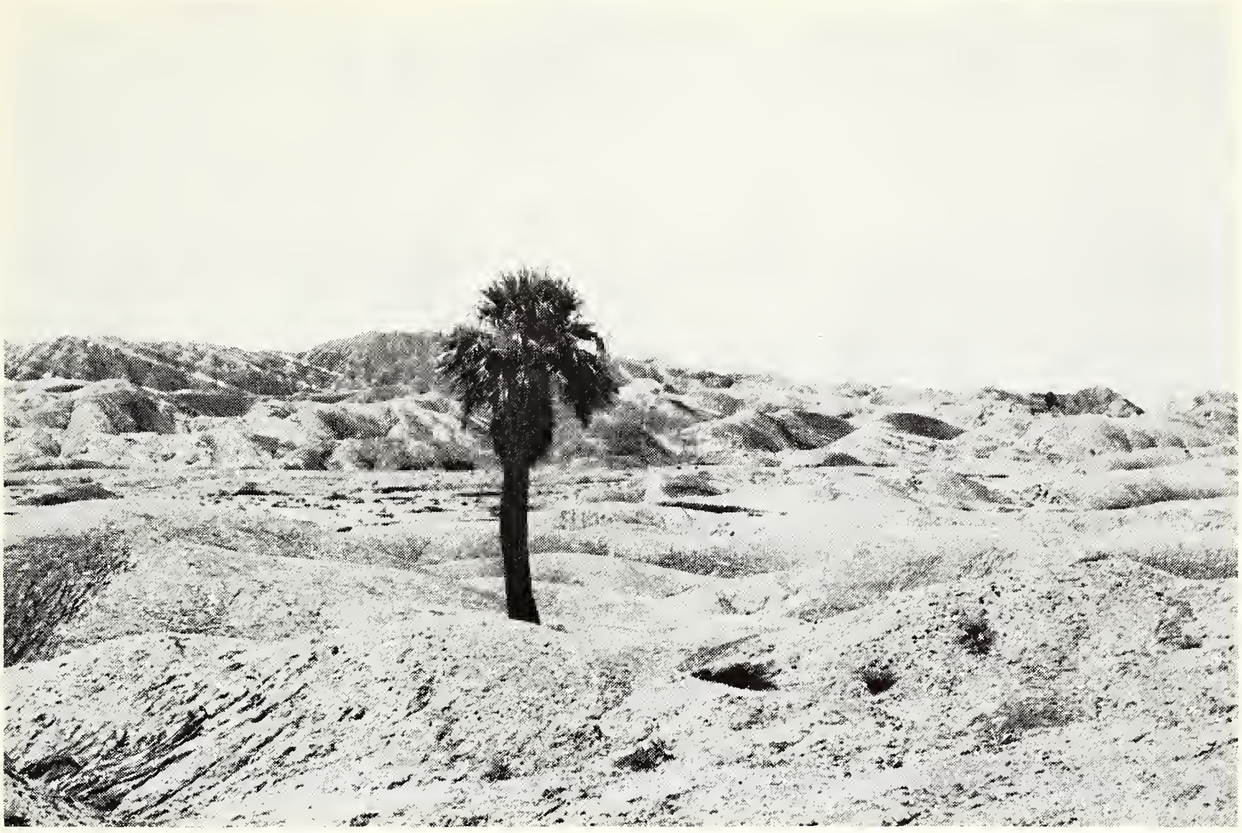

Fig. 5. Isolated *W. filifera* palm in the Badlands of Borrego Desert, California.

Davis (1940) states that the beetles may also occur in the canyons opening into the Borrego Valley. I found evidence of their presence here, although I was unable to collect any palm logs.

E. A. Kane, survey entomologist of the Kern County Department of Agriculture, informed me that he suspected the presence of *D. wrighti* in palms at Oildale, California. He stated that beetles had been taken in the area some 30 years ago. Oildale is about 185 miles north and west of Twentynine Palms, which is the northernmost limits of so-called "natural" stands of *Washingtonia* palms and also *D. wrighti.* Since this is recent information, I have had no opportunity to verify it; these palms were undoubtedly transplanted, and the grubs or eggs of *D. wrighti* may already have been inside the trees.

In a recent communication C. E. Langston, entomologist, Kern County California Department of Agriculture, states that *D. wrighti* was taken from *Washingtonia* palms about a mile and a half from Oildale, California. He gave no date. There is a report (unverified) that the beetles may also occur in the Kofa Mountains in Yuma County, Arizona.

I have been unable to find fossil records of either *W. filifera* or *D. wrighti.* Dr. J. A. Wolfe, U.S. Department of the Interior, Geological Survey, Branch of Paleontology and Stratigraphy, informed me by correspondence that no fossil palms have been assigned to the Genus *Washingtonia*, and that fossil palm leaves are not particularly diagnostic.

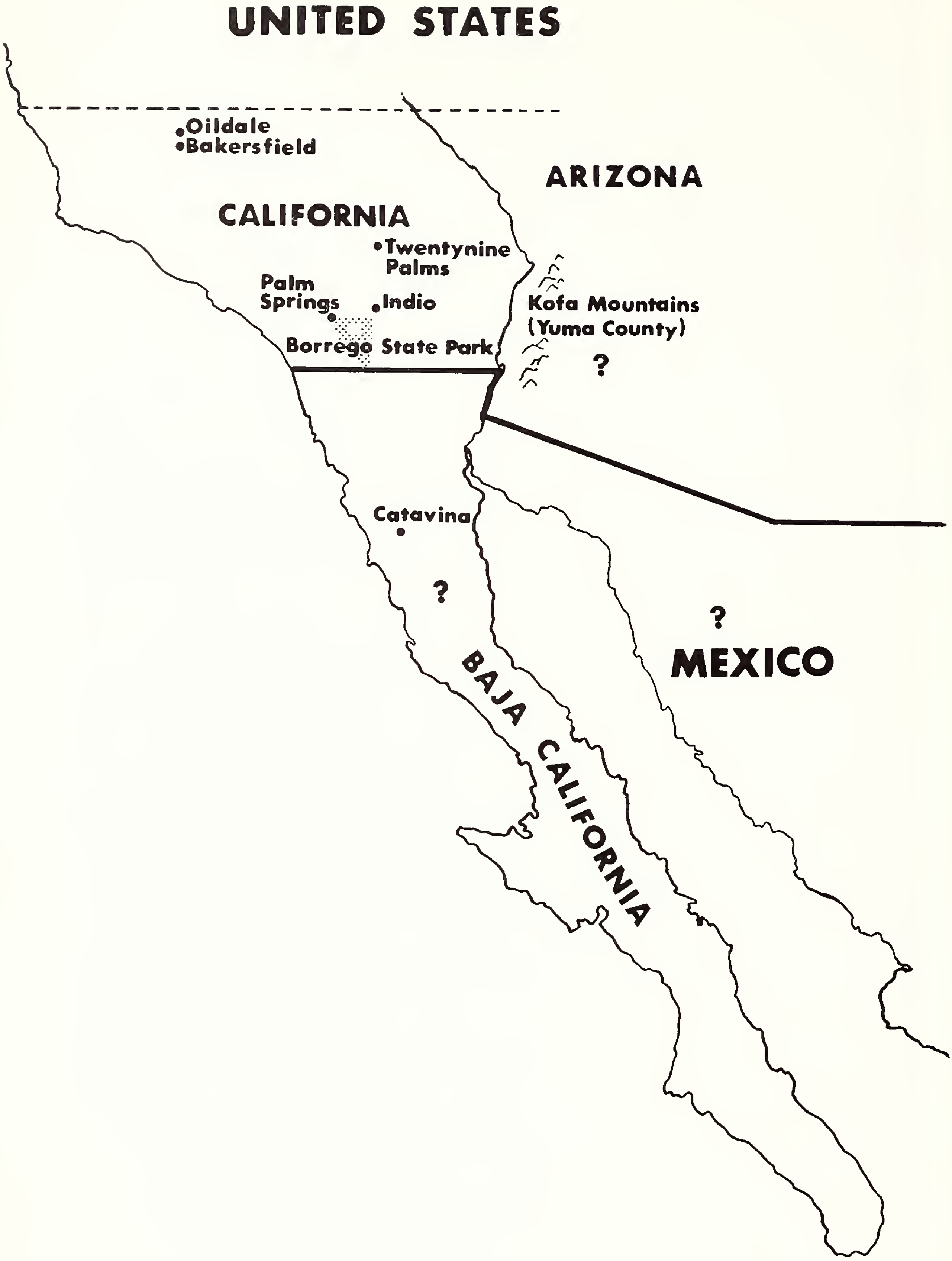

Fig. 6. Collection sites of *D. wrightii*. Question marks indicate areas still to be investigated.

CONCLUSIONS

The time from egg to adult appears to be from three to five years, depending upon temperature, humidity and other ecological conditions. Several broods may occur in the same trees of the larger palms, and over the years this constant activity may kill the trees. The first sign is the drying and browning of the leaves, due to constant eating out of the crown bases. In trees that have been so killed, the crowns eventually fall off. Trees that have fallen and lain for some time may contain living grubs. Apparently even the dry fibers of dead trees afford nourishment for them. Cellulose-conversion is possibly accomplished by bacterial action since no protozoan parasites were found in the gut.

After emergence, particularly in large oases of older palms, the adults may begin re-burrowing into the same tree. They are capable of long flights, and may fly to other trees in the same oasis, or even to palms many miles distant. Such flights are made soon after emergence. If competition is great, entire broods migrate to other groves. Palms are probably located by olfactory structures in the antennae.

There appears to be no danger of the palms being wiped out through their activities, since some of the larger oases are known to have existed for perhaps a hundred years or more, and have no doubt been infested long before the discovery of the beetles in 1886. New palms are constantly springing up from the dropped seeds, especially in the larger oases. In every stand of palms investigated, some evidence of the beetles—or their presence—was noted.

The worst enemies of the beetles, at least when in flight, are large insectivorous bats. In the trees they may be killed by fungi. The only parasite known at present which attacks the grubs and adults is the dipterous parasitic fly, *Sarcophaga helicis* (Aldrich, 1915).

The *Washingtonia* fan palm and the giant palm-boring beetle seem ecologically well balanced.

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Description of the Larval Stage of *Rhyacophila vuphiphes* Milne[1] (Trichoptera: Rhyacophilidae)

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Abstract: The larval stage of *Rhyacophila vuphiphes* Milne is described. It appears to prefer small rivers. Water quality parameters are given.

The caddisfly genus *Rhyacophila* has 26 species in eastern North America (Flint, 1962). The larval stages of most of these were unknown until Flint's work, which described all but 4 of the eastern species. One of these undescribed larvae, *R. vuphiphes* Milne, has been reared and is described below.

Rhyacophila vuphiphes Milne, Length of largest mature larva 17 mm. Head yellowish brown, the frontal suture bordered with black. Two dorsal longitudinal dark bands extend to the frontal suture, forming a distinct "H" pattern dorsally. A few indistinct muscle scars present (Fig. 1). Mandibles as in Fig. 2. Pronotum bordered by black both anteriorly and posteriorly (Fig. 1). A single well developed gill-like filament anterodorsal to the coxal bases on the meso- and metathorax. Abdomen purplish in alcohol preserved specimen, dark green in life. Anal leg with a free basoventral hook. Apicolateral spur short and decurved. Anal claw with one large and one small accessory tooth (Fig. 3). This description based on 18 larvae from the following locations: Little River, Oconee Co., S. C., 4 larvae; Tallulah River, Rabun Co., Ga., 5 larvae; Tugaloo River, Stephens Co., Ga., 9 larvae.

DISCUSSION

Rhyacophila vuphiphes will key to *R. amicis* Ross in Flint's larval key (1962), but can be separated from the latter by the distinctive "H" pattern on the head. *R. vuphiphes* apparently constructs the pupal chamber of small pebbles in the early summer. The larva remains in this chamber for several weeks prior to pupation, which takes place in late August. The adults emerge a few weeks later. The few pupae collected had constructed their pupal chambers on the underside of rather large rocks 1–2 feet in diameter in riffle areas.

R. vuphiphes is restricted to eastern North America (Ross, 1956). We have collected specimens only in small, rocky rivers, averaging about 40 meters in width, in the southern Appalachian foothills (800–1,200 ft. elevation).

Acknowledgments: We wish to thank Dr. H. H. Ross for verification of the adult specimen of *R. vuphiphes*.

[1] This research was supported by Grant No. 18050 from the Federal Water Quality Administration, U. S. Department of Interior.

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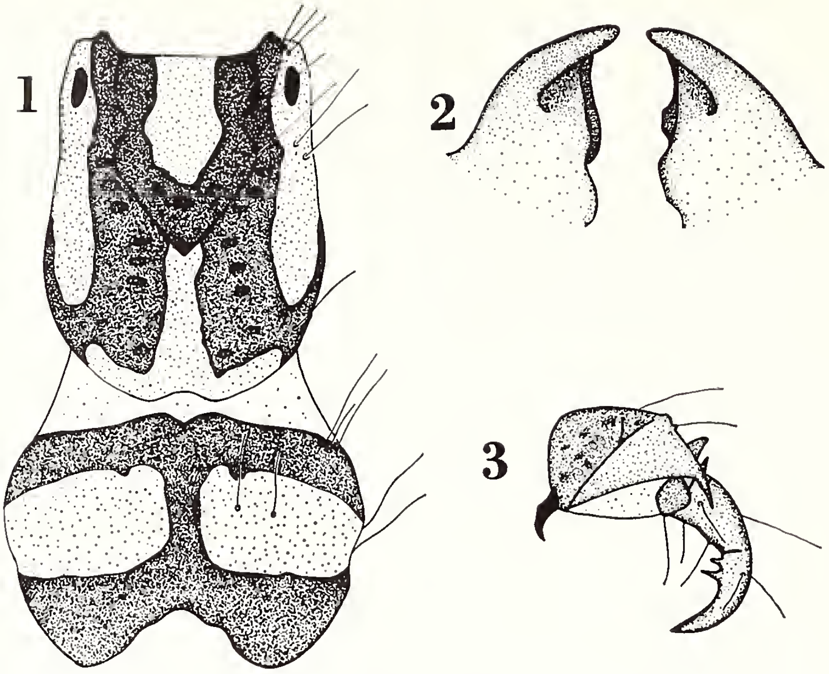

Rhyacophila vuphiphes Milne, larva: Fig. 1, head and pronotum; Fig. 2, mandibles dorsal view; Fig. 3, anal leg and claw

Larvae and adults have been collected over the following range of water quality parameters: temperature 3.6–24°C; pH 5.6–7.1; conductivity 12.3–42 microhms; turbidity 8–86 J.U.; alkalinity as $CaCO_3$ 10–20 ppm; nitrate .261–.44 ppm; nitrite .001–.006 ppm; ammonia nitrogen .25–.64 ppm; orthophosphate .16–.20 ppm; total phosphate .20–.25 ppm; sulfate 0–2.5 ppm; dissolved oxygen 5.5–11.9 ppm.

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Vol. LXXIX, March, 1971

New Genus of Mayflies from Eastern North America[1] (Ephemeroptera: Ephemeridae)

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Abstract: Based on a detailed morphological study of the family Ephemeridae, a new genus, **Litobrancha**, is erected to include **Litobrancha** *recurvata* (Morgan) comb. n. which was previously placed in the genus *Hexagenia* Walsh. The description is based on several previously unstudied characters along with some heretofore regarded as being of only specific importance. Both nymphal and adult stages of **Litobrancha** are compared with those of *Hexagenia*. The relative phylogenetic position of the new genus is discussed, and the distribution and biology of **L.** *recurvata* are reviewed.

Information gained through a comprehensive phylogenetic study of the family Ephemeridae has indicated that certain revisions in regards to the generic classification of this group are necessary before a more natural classification can be realized. Morphological differences pertaining to both nymphal and imagal characters, between the species previously known as *Hexagenia recurvata* Morgan and all other known species of the genus *Hexagenia* Walsh are widespread and distinct. For this reason the erection of a new and separate genus to include the above mentioned North American species is believed warranted. This new genus is herewith named **Litobrancha**.[2]

Litobrancha new genus

IMAGO

SIZE: Length of male body, 18.0–20.5 mm.; fore wings, 15.0–18.0 mm.; lateral cerci 1.9–2.6 times length of body; median terminal filament vestigial. Length of female body, 19.0–28.0 mm.; fore wings, 19.0–24.0 mm.; lateral cerci 1.6–2.4 times length of body; median terminal filament vestigial.

HEAD: Compound eyes of male bicolorous, approximated dorsally; median margins strongly convergent dorsally in facial view (fig. 1). Compound eyes of female unicolorous, separated anteriorly by distance 2.2–2.4 times width of one eye; median margins convergent dorsally

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Acknowledgments: I wish to thank Dr. L. L. Pechuman of Cornell University, and Dr. Jay R. Traver, Amherst, Massachusetts, for the loan of specimens of *L. recurvata*. I would also like to acknowledge Dr. George F. Edmunds, Jr. of the University of Utah for his assistance on the research dealing with the Ephemeridae, and also Dr. Andrew H. Barnum for his review of the manuscript.

[1] Research was in part supported by an NSF Grant to Dr. George F. Edmunds, Jr. for studies on the higher classification of the Ephemeroptera.

[2] Etymology: Litos, Gr. meaning simple; branchos, Gr. meaning gill.

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in facial view (fig. 2). Transverse shelf of head below antennae extended ventral to nasal carina and bilobular as seen in facial view (figs. 1 and 2).

THORAX: Pronotum with posterior width approximately 1.5 times length; lateral margins tapered anteriorly to width three fifths to two thirds of posterior width; pronotum not constricted sublaterally in anterior third. Scutellum of mesothorax variable, usually acute posteriorly as seen in dorsal view (fig. 3), if notched then only very slightly (fig. 4), never deeply concave. Length of male body 1.2–1.3 times length of fore legs; tibiae of fore legs 1.4 times femora; tarsi 1.4–1.6 times tibiae. Length of female body 2.2–2.6 times length of fore legs; tibiae of fore legs 0.8–1.0 times femora; tarsi 0.9–1.0 times femora. Fore wings (fig. 5) with crossveins not crowded along line of bullae; A_1 nearly straight to slightly sinuate, not exactly paralleling CuP; 2–4 veinlets extending between A_1 and anal margin; A_2 paralleling A_1 for over one half of its length. Hind wings (fig. 6) with MP_2 not attached basally to CuA; A_1 ending on margin over one half of length of anal margin; anal venation with much reticulation.

ABDOMEN: Genitalia of male (fig. 7) with posterior margin of subgenital plate slightly emarginate medially; forceps four-segmented, second segment curved medially mostly in distal half, dorsal to semi-globose basal segment at attachment, third and fourth segments combined over one half of length of basal segment; penes divergent in distal two thirds, with narrowed apices recurved ventrally. Terminal abdominal sternum of female with no distinct posterolateral processes.

MATURE NYMPH

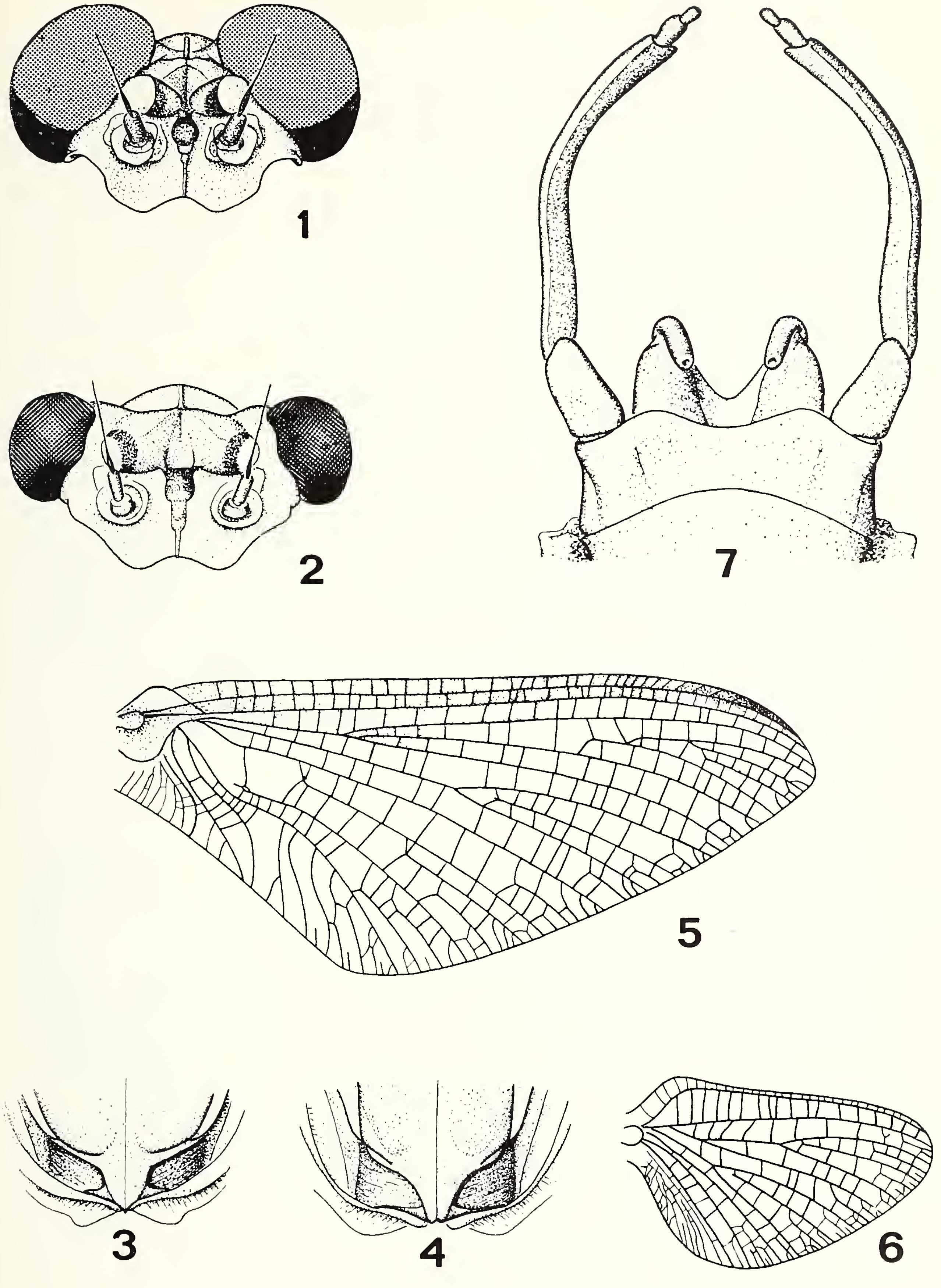
HEAD: Frontal process complete, at least as long as wide; lateral margins slightly divergent from base (fig. 8). Antennae with pedicel at least as long as scape; flagella covered with very short scattered setae (fig. 8). Labrum with distal margin nearly straight (fig. 9). Mandibular tusks stout, circular in cross section, less than twice length of body of mandible, not spuriferous (fig. 10). Hypopharynx with median lingua emarginate (fig. 11). Maxillae slender, palpi three-segmented (fig. 12a); galea-laciniae acute apically, with 1 large tridenticulate apical spine (fig. 12b) and 2 small subapical spines medially, distal subapical spine not as distinct and appearing juxtaposed with apical spine. Labium (fig. 13) with paraglossae distinctly extended basally; palpi two-segmented, terminal segment truncate and spuriferous apically.

THORAX: Tibiae of fore legs produced anterodistally into large acute process dorsal to tarsi, posterodistal margin with distinct comb of stout apical setae. Tibiae of middle legs distinctly produced posterodistally beyond origin of tarsi, and with distinct comb of stout apical setae at posterodistal margin. Tibiae of hind legs with tibial processes nearly equal to tarsi in length.

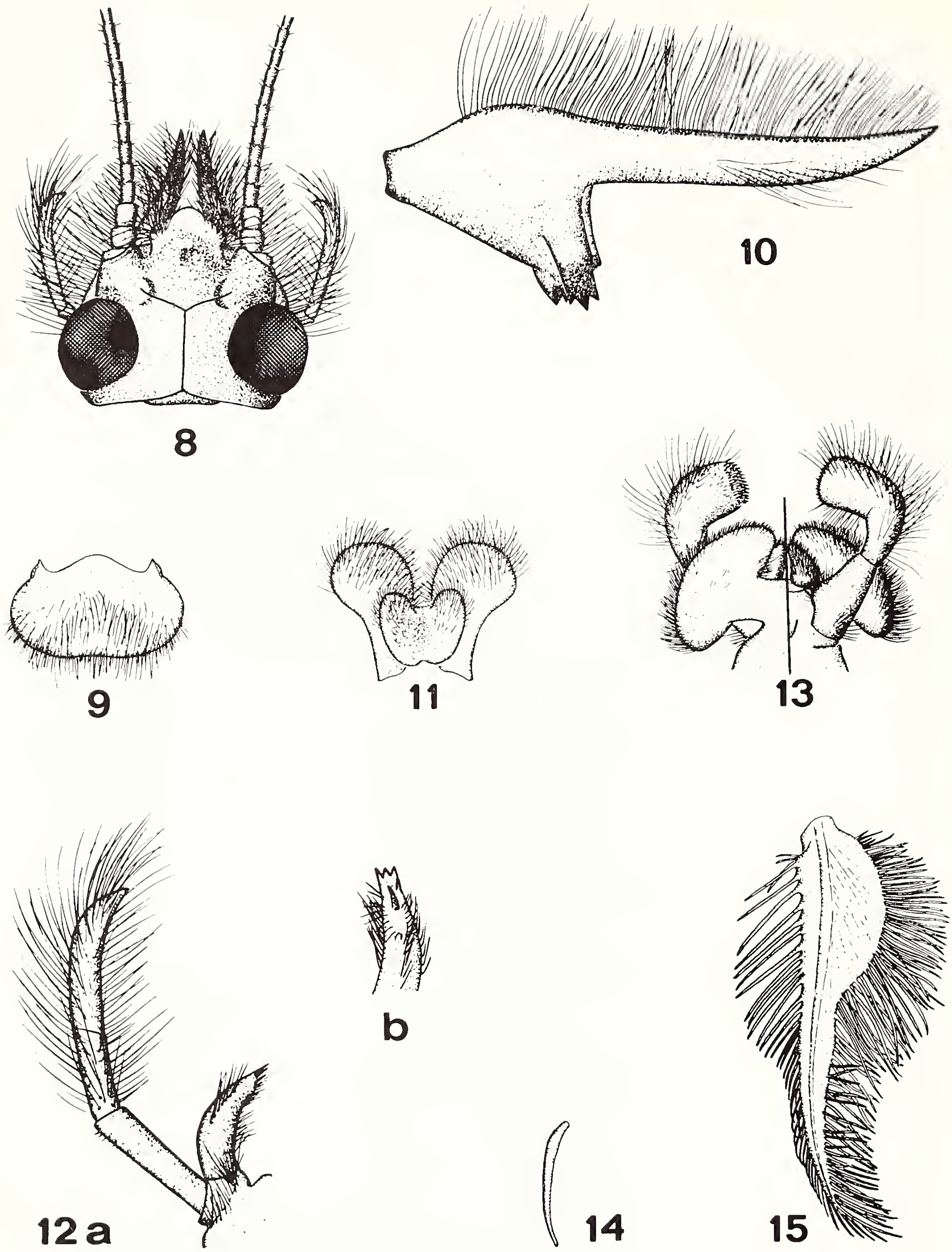
ABDOMEN: Gill 1 slender and unbranched (fig. 14). Dorsal branch of gill 2 with outer margin of lamella distinctly expanded in basal half (fig. 15).

DISCUSSION

Litobrancha *recurvata* (Morgan) comb. n. was discovered to be quite distinct morphologically by Spieth (1941); nevertheless, he maintained its original status in the genus *Hexagenia* in his revisionary work at that time. Prior to this Traver (1931) had noted several nymphal characteristics unique to **L.** *recurvata*. Detailed study of additional characters and specimens of



Figs. 1–7. **Litobrancha** *recurvata*, imago. 1. Male head, anterior view. 2. Female head, anterior view. 3 and 4. Scutellum of mesothorax, dorsal view. 5 and 6. Fore and hind wings respectively. 7. Male genitalia, ventral view.



Figs. 8–15. **Litobrancha** *recurvata*, nymph. 8. Head, dorsal view. 9. Labrum, anterior view. 10. Right mandibular tusk, lateral view. 11. Hypopharynx. 12a. Right maxilla posterior view. 12b. Galea-lacinia, median view. 13. Labium. 14. Abdominal gill 1. 15. Dorsal section of right gill 2.

Ephemeridae from throughout the world however, definitely supports the proposed classificatory change. Based on the total number of character state differences and degrees of differentiation, **Litobrancha** is as distinct as other such natural groups of species presently recognized within the family. Since **Litobrancha** is presently monospecific, an effort has been made to incorporate in the description those characters which have proven to be of generic consequence for the family as a whole. Certain of the generic characters used herein (with particular reference to measurements) may necessarily be modified if in the future the genus is found to include additional species.

Litobrancha and *Hexagenia* can be generically differentiated very clearly on the basis of several characters, many of which have not been previously studied. The more important diagnostic characters include the following: The compound eyes of the male imago are more convergent dorsally in **Litobrancha** (fig. 1), being convergent only slightly in most *Hexagenia*. Regarding the compound eyes of the female imagos, they are unicolorous in **Litobrancha** (fig. 2) and bicolorous in *Hexagenia*. A striking difference occurs in the shape of the head of the adults (see figs. 1 and 2). In the anterior or facial view, the head of **Litobrancha** is extended ventrally on either side of the midline or nasal carina, appearing somewhat bilobular. However, in *Hexagenia*, this transverse shelf of the face below the antennae is not extended as far as the nasal carina, and may appear slightly concave on either side. The next important distinguishing feature between the two genera pertains to the thoracic morphology. The scutellum of the mesothorax of *Hexagenia* is notched posteriorly as seen in the dorsal view. In **Litobrancha** the scutellum is usually acute posteriorly (fig. 3); if it is notched (fig. 4) it is much less so than that condition found in *Hexagenia*. In the anal area of the fore wings, **Litobrancha** possesses 2–4 veinlets extending from A_1 to the anal margin, and A_2 parallels A_1 for over one half of the length of A_2 (fig. 5). Whereas, in *Hexagenia*, as pointed out by McCafferty (1970), species of the Nearctic subgenus *Hexagenia* s.s. usually have 8–14 veinlets and never less than 5, only species of the Neotropical subgenus *Pseudeatonica* having as few as 3 veinlets. In addition A_2 is divergent with A_1 for more than one half of the length of A_2 in *Hexagenia*. Concerning the male genitalia of **Litobrancha**, the dorsal side of the basal segment of the forceps is extended somewhat distally beyond the point of attachment with the second segment (fig. 7). This is not the case in *Hexagenia*. The study of the Ephemeridae has shown that the general shape of the penes is of consequence in delineating the genera, and here again **Litobrancha** and *Hexagenia* differ. The penes are separate to their bases in *Hexagenia*, but attached and divergent only in the distal two thirds in **Litobrancha** (fig. 7). Moreover, the tips of the penes are peculiarly recurved ventrally in **Litobrancha**, a condition not occurring in *Hexagenia*.

Several nymphal characters are also of significance in differentiating the taxa. The flagella of the antennae is whorled with long coarse setae for at least two thirds of its length in *Hexagenia*, but possesses only very short, sparsely located setae in **Litobrancha** (fig. 8). The frontal process is more angular in **Litobrancha** as seen in figure 8, and typically rounded in *Hexagenia* with lateral margins convergent from the base. The mandibular tusks also appear shorter and more stout relative to the head in **Litobrancha**. In regards to these above mentioned nymphal characters, it is of interest to note that Needham (1920), in his study of North American burrowing mayflies, misfigured the head drawings of **L.** *recurvata* and *H. bilineata* (Say) so that the attributes of each appear opposite of that discussed above. The median lingua of the hypopharynx is deeply emarginate in **Litobrancha** (fig. 11), and straight to very slightly emarginate in *Hexagenia*. The apical spine on the galea-lacinia of the maxillae is tridenticulate in **Litobrancha** (fig. 12b) and bidenticulate in *Hexagenia*. The first abdominal gill of **Litobrancha** is unbranched (fig. 14), whereas the first gill of *Hexagenia* is bifid from near its base.

Phylogenetically, **Litobrancha** is most closely related to the genera *Eatonica* Crass, *Eatonigenia* Ulmer, and *Hexagenia*, sharing many characteristics with them. Present evidence based on derived character states in common shows **Litobrancha** to perhaps hold more affinities for the Old World genera *Eatonica* and *Eatonigenia* than for *Hexagenia*. If in fact **Litobrancha** shares a most recent common ancestor with the evolutionary line leading to *Eatonica* and *Eatonigenia*, it stands somewhat intermediate between *Hexagenia* and the latter two, along with having many specialized characteristics of its own.

The known distribution of **Litobrancha** is based on reported records of **L.** *recurvata*, see Spieth (1941). Its distribution is centered in the northeastern United States, but it has been reported from Ontario and Quebec, north; the upper peninsula of Michigan, west; and North Carolina, south.

The biology of **L.** *recurvata* has been variously treated by Morgan (1913), Needham (1920), Morgan and Grierson (1932), Morgan and Wilder (1936), and Spieth (1941). Needham referred to this species as an upland bog-stream species, and in fact **L.** *recurvata* is usually associated with colder and swifter streams than are other North American burrowing mayflies. As pointed out by Spieth, the relatively small populations of this species may be due to this restricted habitat. The species reportedly emerges during May and June of each year in the northeastern United States.

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Experimental Studies on the Phycomycosis of Muscoid Flies Caused by *Entomophthora muscae* (Cohn)

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Abstract: *Entomophthora muscae* (Cohn) was successfully transmitted from *Hylemya antiqua* to *Phaenicia cuprina* and from *P. cuprina to Phormia regina* in the laboratory. Further attempts at transmission were unsuccessful. Possible reasons for this failure are discussed. The post-mortem appearance of diseased flies (*Pollenia rudis*) varies considerably even under similar environmental conditions. It is suggested that some factors other than humidity, temperature and light regulate the post-mortem changes in the fly and the concomitant development of the fungus.

The most universally recognized disease of muscoid flies is the phycomycosis of imagoes caused by *Entomophthora muscae* (Cohn) (= *Empusa muscae* Cohn) and much of the world's literature pertaining to this disease has been skillfully reviewed by Müller-Kögler (1965). While the cytology and developmental cycle of the pathogen are rather well understood, no completely satisfactory method for its continuous culture *in vivo* or *in vitro* has been developed and the intrinsic and extrinsic factors that govern the invasiveness of infective conidia remain obscure. Hence experimental investigations on this disease continue to be limited in scope and number. The present studies, however, provide some new records on the transmission of *E. muscae* in the laboratory and some new information concerning the outcome of the fly-fungus interaction under monitored conditions of temperature, humidity, and light.

EXPERIMENTAL TRANSMISSION OF *E. muscae* IN THE LABORATORY

In early June of 1962, I found more than a dozen cadavers of onion flies *Hylemya antiqua* (Meigen) affixed to the tips of blades of grass near a cultivated field in Urbana, Illinois. The swollen white-banded abdomens of these lifeless creatures were producing conidia in profusion. On microscopic examination the conidia proved to be uniformly bell-shaped with a pointed apex; clearly the fungus involved was *E. muscae.* In the same area and at the same time, I collected four sluggish *H. antiqua* whose abdomens were abnormally pale in color. These sick flies were placed in a one-gallon glass battery jar containing a thick layer of wet sand, a water bottle with a cotton wick, and a small dish of powdered milk and sugar. Ten young adult bronze blow flies *Phaenicia cuprina* (Wied.) from a healthy laboratory culture were also placed in the jar which was covered with several layers of gauze. The jar of flies was

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placed on a laboratory bench where it received some artificial light from an overhead frosted incandescent lamp during the day plus a little natural light from a nearby window.

Within 24 hours after the two species of flies were caged together, the four *H. antiqua* had succumbed to the mycosis; two were anchored to the wick of the water bottle and two to the side of the jar. All four cadavers were producing conidia. By the sixth day following their introduction to the jar, eight of the ten *P. cuprina* were dead and displayed the typical post-mortem changes associated with the mycosis; on the same day ten newly emerged black blow flies *Phormia regina* (Meigen) from a disease-free culture were added to the jar. Nine of the *P. regina* had died of the disease six days later. A second group of ten *P. cuprina* was then added; after two weeks four of the *P. cuprina* were dead but they contained no fungal growths. The remaining six *P. cuprina* lived for an additional 12 to 21 days but they developed no signs or symptoms of the mycosis.

Why the conidia produced from the *P. regina* failed to infect the second group of *P. cuprina* is not known. The temperatures within the laboratory fluctuated between 21° and 24°C. The relative humidity within the jar was not measured but some condensation, in the form of minute droplets on the inside of the jar, was present throughout the entire observational period. Apparently no dramatic changes in the amount and quality of light reaching the flies and the fungus occurred. Baird (1957) also observed a rather sudden and unexplainable cessation in the transmission of *E. muscae* under laboratory conditions. His findings and those of the present study suggest that some very subtle changes in the micro-environment of the conidium probably govern its ability to successfully invade a new host. Previous accounts of fly-to-fly transmission of *E. muscae* under laboratory conditions plus those of the present study are summarized in Table 1. Note that the time which may elapse between exposure to conidia and death of the fly may vary from three to 14 days.

POST-MORTEM APPEARANCE OF FLIES DYING UNDER MONITORED CONDITIONS

In early October of 1969, I found several cluster flies *Pollenia rudis* (Fabr.) that had succumbed to the phycomycosis generated by *E. muscae* in a cage of miscellaneous muscoids that had been trapped for another purpose in Ithaca, New York. The living *P. rudis* from this collection plus a score of active *P. rudis* taken at windows were placed in separate cylindrical one-half pint cartons with glass covers. Each carton was provisioned with a dry milk-sugar mixture and a vial of water with a cotton plug. These cages rested on a laboratory bench and the flies received constant light from three 100-watt overhead incandescent frosted light bulbs. Little or no natural light reached these cages. At frequent intervals each fly was observed and its condition noted.

TABLE 1. Accounts of successful fly-to-fly transmission of *Entomophthora muscae* (Cohn) by conidia under laboratory conditions.

Species Infected	Source of Conidia	Environmental Conditions	Days from Exposure to Death	Author & Reference
Musca domestica L.	*M. domestica*	Closed glass cage moist & warm*	6 to 10	Güssow, 1913
M. domestica	*M. domestica*	(as above)	3 to 8	Yeager, 1939
Kellymyia kellyi (Ald.)	*K. kellyi*	Closed cages, 24°C. & 50% R.H.**	3 to 11	Beard, 1957
Pseudosarcophaga affinis (Fall.)	*K. kellyi*	(as above)	7 to 14	Beard, 1957
M. domestica	*K. kellyi*	(as above)	6 to 7	Beard, 1957
Phaenicia cuprina (Wied.)	*Hylemya antiqua* (Meig.)	Closed glass cage*** 21–24°C & very humid	5 to 6	(present study)
Phormia regina (Meig.)	*P. cuprina*	(as above)	5 to 6	(present study)

* = natural light.
** = in natural and artificial light.
*** = mainly in artificial light.

TABLE 2. Types of post-mortem changes in *Pollenia rudis* that succumbed to the phycomycosis caused by *Entomophthora muscae*.*

Appearance of Cadavers		Condition and Contents of Abdomens 48 Hours after Death	No. Specimens Observed
At Death	Within next 24 hours		
Wings, legs & proboscis extended; abdomen distended	Distended abdomen producing a shower of conidia	Abdomen withering and filled with fungal remnants	17
(as above)	No fungal bloom from distended abdomen	Abdomen withered and containing a mixture of hyphal bodies and fragmented host tissues	9
Wings, legs & proboscis withdrawn; abdomen normal	(as above)	(as above)	5

* Environmental conditions: 22–24°C and 50–53% R.H.

Manipulative procedures are indicated in Table 2. Throughout the observational period temperatures within the cages ranged from 22 to 24°C and the relative humidity from 50 to 53 per cent. The results obtained are summarized in Table 2. *P. rudis* not dying of the mycosis have been omitted from this tabulation.

According to Graham-Smith (1916), Hewitt (1914), Howard (1911), and others the afflicted fly dies in a somewhat lifelike stance: the wings and legs are spread out slightly, the distended abdomen droops, and the proboscis is partly or wholly extended. It is further suggested by these authors that from a few hours to several days after the fly dies the fungal bloom appears if conditions of humidity and temperature are favorable. That a life-like pose is not an invariable eventuality in flies killed by this mycosis is indicated in Table 2. While about 50% of the dead *P. rudis* displayed typical post-mortem changes, the other 50% never developed the characteristic abdominal changes associated with the disease. More than 20% of them also lacked the typical postures found in the proboscis, wings and legs. All flies were found to harbor the fungus internally however.

The foregoing observations suggest that some intrinsic or extrinsic factors other than humidity, temperature and light regulate the post-mortem changes in the fly and the concomitant development of the fungal pathogen. If environmental humidity, temperature and light alone were responsible, one would have expected a uniformity in appearance of the cadavers since all flies were held under the same conditions relative to these factors.

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BOOK REVIEWS

The Flies of Western North America, by Frank R. Cole (with the collaboration of Evert I. Schlinger), 1970. xi 693 pp. University of California Press, Berkeley, California. Cloth, $25.00.

This large work is essentially a compilation from the literature—only a few families such as the Acroceridae and Cecidomyidae were revised especially for the work. The lengthy introduction defines the area studied and discusses its ecology, biogeography, life zones, etc. There is also a short section on Geologic history and a lengthy discussion of general anatomy. The key to families is modified from that in Brues and Melander (1932). Each family treatment contains keys to subfamily (if nesessary) and to genera. Under each genus the original citation is given and there is a listing and some discussion of the western species which fall in that particular genus. There are no keys to species and it would be very difficult to identify species with this work. The illustrations, particularly the full figures by Dr. Cole, are very good and are well reproduced. A great many are reproduced from Curran's Manual.

This book was many years in preparation and consequently some of the families or subgroups have been more recently revised but this would be true of any compilation of this kind. Since the source of each key is given the reader can refer back to the original work and is aware of the date of the key in question.

One unfortunate error has occurred in the table (p. 100) comparing the Townes—Johannsen classification of the Chironomidae with that of Freeman. The lines below Limnophyes through Tanytarsus in the second column do not correspond to their equivalents in column 1. The reader should consult the table on p. 143 of the Catalogue of North American Diptera.

The closing sections of the volume consist of a glossary, selected bibliography and an index to families, subfamilies, tribes, genera, and species.

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Biology of Termites. Volume 1. Kumar Krishna and Frances M. Weesner (eds.). Academic Press, New York. 1969. 597 pp. $32.00.

Drs. Krishna and Weesner have combined their talents with those of 13 other experts (representing 5 countries) to produce this volume on the biology and behavior of termites.

In an introductory chapter, Dr. Krishna outlines Isoptera classification, one which draws heavily upon the work of the two most noted researchers on termites: A. E. Emerson and T. E. Snyder.

Dr. Weesner in Chapter 2 presents such clear diagrams of the external anatomy that they could serve as an introductory entomology textbook. He describes in Chapter 5 the anatomy and physiology of the reproductive systems representative of different castes.

The digestive system is described in Chapter 3 by Drs. Noirot and Noirot-Timothee. They present a comprehensive anatomical review and discuss the physiology of digestion.

Dr. Noirot reminds us in Chapter 4 how fragmentary our knowledge is concerning the source and role of many exocrine secretions. In Chapter 10 he treats caste differentiation in Termitidae, where postembryonic development is stereotyped and less reversible than in other families.

The nervous system and sense organs are described by Dr. Richard in Chapter 6. He has illustrated it with beautiful model reconstructions of termite brains.

In Chapter 7 Dr. A. Stuart discusses the role of foraging, trail following, nest construction, colony odor, and alarm reactions in colony organization and draws heavily from his own studies. Only a few cursory references are made to the work on corresponding aspects of the social organization of ants.

Flight and the foundation of colonies is discussed in Chapter 9 by Dr. W. Nutting. Emphasis is on the flight season and the diverse factors that regulate flight. The sections on postflight behavior overlap somewhat with a similar section on sexual behavior in the preceding chapter, but each enhances the other.

In Chapter 9, Dr. E. Miller reviews the physiology of caste determination in lower termites (i.e., Hodotermitidae, Kalotermitidae and Rhinotermitidae). He presents evidence that newly hatched larvae are equipotent, with their future castes determined by social (mainly pheromonal) and environmental factors.

Of particular interest is Chapter 11 by G. Becker on rearing termites in the laboratory. Sections on nutrition, aeration, humidity, temperature, disease and the prevention of termites' escape from laboratory nests, include illustrations of many types of apparatus.

In Chapter 12 Dr. E. McMahan discusses the feeding relationships and the use of radioisotopes in monitoring food exchange.

Biochemical studies are presented in Chapter 13. Dr. B. Moore discusses the digestion of cellulose, the chemistry of pigments, vitamin and lipid metabolism, and the chemistry of pheromonal secretions.

Water relationships are the subject of Chapter 14. Dr. M. Collins examines factors influencing survival time during experimental desiccation.

Chapter 15 describes the introduction of termite species into new countries. In a nine-page table, Dr. E. Gay lists 42 species that have been introduced into new areas, their countries of origin and introduction, and their present ecological status.

In Chapter 16 Dr. W. Sands reviews the mutualistic, saprophytic and pathogenic associations between termites and fungi.

The last chapter (17) is a discussion by Dr. D. Kistner of the biology of termitophiles. He concludes that many termite guests have speciated "within the framework of the phylogentic pattern of their hosts."

Howard R. Topoff
The American Museum of Natural History

Review of the Mite Family Cheyletidae. Francis M. Summers and Douglas W. Price. Sept. 17, 1970. vi, 153 pp., 59 figs. University of California Publications in Entomology, **61**. Berkeley, Los Angeles, London: University of California Press. $5.50 paperbound.

With some 50 genera and about 186 described species, the cheyletids are an important group of prostigmatic mites common throughout most of the world in granaries, barns and stables, in leaf litter and soil, and sometimes on plants. Though some are associated with birds and mammals, and even, on occasion, with insects, most are free-living predators on other small arthropods. Since E. W. Baker's review of the family in 1949, many new species have been discovered and much systematic work has been done, particularly by Volgin in Russia. Summers, who was for some time a member of the faculty at the College of the City of New York, has now for many years been Professor of Entomology at the University of California at Davis, and Entomologist at the Davis Experiment Station, where he has done much significant work in applied entomology. "The work in mite systematics," he writes (in correspondence), "is a sort of hobby because I have spent most of my efforts . . . on how to out-manage the insects and mites on peaches and almonds." Many of Summers' publications (including one in 1961 with his present collaborator Price, than a laboratory technician at Davis) have dealt with mites of the superfamily Raphignathoidea. The work here reviewed, according to the introduction, "evolved out of difficulties encountered by the authors in identifying cheyletid mites taken in commonplace situations." It would be a blessing to acarologists if such difficulties always yielded such useful evolutionary results!

The five-page introduction gives some taxonomic and morphological background and is followed by a key to the genera, based upon females only. Males, for reasons given on page 5, are not dealt with in this study. Each genus and species is then discussed individually, with synonymies, definitions, comments, collection and type data, and carefully constructed keys. The figures, ample and well drawn in a fine-lined but somewhat sketchy style, are printed on glossy paper forming the last 60 pages of the book. Most figures are accompanied by 100-micron scales. One new genus (*Laeliocheyletia*) and 12 new species are described. One who delights in knowing the etymological origins of scientific names will regret that this information is not given for the new taxa.

The basis for the arrangement of genera is not specified, and the introduction states that "students of this group of mites are as yet unable to assess the phylogenetic implications of external characters." The sequence chosen, however, seems to procede from more generalized to the more modified forms. The treatment in general is conservative, and taxonomic departures from the views of previous workers (chiefly consolidation of some of Volgin's genera) are taken only after careful consideration.

There is a bibliography of 118 titles, and an index of species arranged alphabetically according to their respective genera. The book is well edited, beautifully and legibly printed by letterpress on good quality paper. Those who use the keys will appreciate the excellent binding that allows the opened book to lie flat on the table. The price, by current standards, is not excessive. Acarologists will long be grateful to Summers and Price for this fine monograph.

Asher E. Treat, Research Associate
The American Museum of Natural History

Springtime in Britain. Edwin Way Teale. 1970. 391 pp., 38 black and white photographs. Dodd, Mead and Company, New York. $7.50.

Gerard Manley Hopkins once wrote:

What would the world be, once bereft
Of wet and of wildness? Let them be left,
O let them be left, wildness and wet;
Long live the weeds and the wilderness yet.

The Teales found many days that were wet in their 11,000 miles of travel, criss-crossing Britain from Land's End, on the southwestern tip of the Cornish peninsula, to northern Pentland Firth where John de Groot's ferry sailed three centuries or more ago. And there in that ancient land, the home of their fathers, they found a certain wildness, too, seeing it with fresh eyes and perceiving it with the wisdom garnered from their rich background. They are intimately acquainted with the great natural history writers of England's past: Gilbert White, Henry W. Bates, W. H. Hudson, Lord Grey of Fallodon, and others: and with many lesser ones—lesser in widespread popularity but not in the expression of their love for the English countryside. Some of these writers were aristocrats; others were peasants; others, eccentrics; but all had helped the Teales prepare for this springtime journey. The Teales visted their homes, followed the same badger trails, and stood in the shade of the same giant yew, "a century old when King Alfred was alive."

The Teales were seeing Britain for the first time. Their eyes were quick to note the infinite range in color of the thatched roofs; to catch the race of the bore in the Severn Estuary; and to glimpse the diamond-shaped stones in an old farm building, cut like the ancient roof tiles on the Roman villa newly excavated at Rockbourne. Their ears could hear the truncated call of one wee lamb in a bleating flock, as well as the high-pitched song of the grasshopper warbler, inaudible to many human ears. They found the little bog orchid hidden in the sphagnum moss on Dartmoor, seen only twice in 85 years; and they counted the swifts flying over the church in Selbourne as they had been counted by Gilbert White in 1778.

The book contains a wealth of miscellaneous information ranging from the quirks of pampered geese to the composition of the Sarsen sandstone on the Marlborough Downs. The words are precise but the phrases flow "as a frog slips into a summer's pond;" and the sentences illuminate and encompass: "All up and down our beach of shells, under a sun that sank so slowly it seemed standing still in the northwestern sky, a pair of nesting ringed plovers flitted above us, uttering soft and anxious cries."

Springtime In Britain is to be savored—a chapter at a time. It is not a travelogue, but in reading it you come to such terms of intimacy with Britain, its history, its poets, and its countryside that you feel that you have been traveling with Ed and Nellie Teale. However, you will want to have a map beside you as you read, for the one provided on the end papers shows only their route and is inadequate. The index is excellent; and the 38 black and white photographs, all taken by the author, superb. For this reviewer the picture of Hudson's seat on the tor above Zennor is unforgettable; and that of the 13 white-faced heifers, pressed side by side, watching the Teales rowing down the Avon, is linked forever with the benediction on that day's sojourn. "For us, Shakespeare's river will flow, without ceasing, through an unending English spring."

This book will stand for all time beside the well-loved works of the great English naturalists.

Elsie B. Klots

BUTTERFLY SPECIMENS WANTED

W. V. Krivda (P.O. Box 864, the Pas, Manitoba, Canada) wishes to obtain short series of uncommon indigenous butterflies. Locality and condition of specimens is not important. In exchange he can offer *Colias gigantea mayi* and other northern species available in season.

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More Records of New Jersey Aphids (Homoptera: Aphididae)

MORTIMER D. LEONARD[1]

COLLABORATOR, ENTOMOLOGY RESEARCH DIVISION, AGRICULTURAL RESEARCH SERVICE,
U.S. DEPARTMENT OF AGRICULTURE, WASHINGTON, D.C.

RECEIVED FOR PUBLICATION SEPTEMBER 9, 1970

Abstract: Listed are 102 aphid species arranged alphabetically by genera and by species under each genus. Detailed records of the localities, dates, food plants and collectors are given for each species and a list of 128 food plants on which the aphids have been collected is included. Sixteen species of the aphids and 44 of the food plants have not been previously recorded from New Jersey. At present 237 aphids on 311 food plants are now known to occur in this state.

Acknowledgments: As in the past a number of persons, in addition to the writer (MDL), made collections. These again included Drs. Harry W. Allen (HWA) and E. Avery Richmond (EAR) of Moorestown, James A. Stewart (JAS) of the USDA Laboratory at Moorestown, Donald D. Leonard (DDL) of Ridgewood, David L. Winters (DLW) of Haddonfield, Mrs. W. Graham Rendell collected on house plants at Glen Rock. Members of the staff of the Division of Plant Industry, N.J. Dept. Agriculture who made collections during this period include: W. F. Conlon, F. S. Stinson, L. D. DeBlois, G. L. Pope, R. Sayer, W. F. Griner, Addison Driver, and W. A. Junghans.

Several other collectors are mentioned in connection with individual records.

Determinations, other than those by the author, were made by: Miss Louise M. Russell (LMR), Ent. Res. Div., ARS, USDA; Dr. A. Tom Olive (ATO), Wake Forest College, Winston-Salem, N. C.; Dr. Clyde F. Smith (CFS), North Carolina State University, Raleigh, N. C.: Prof. Emeritus John O. Pepper (JOP) Pennsylvania State University, University Park, Pa.; Prof. Emeritus Theo L. Bissell (TLB), University of Maryland, College Park, Md.; Prof. Emeritus Archie N. Tissot (ANT), University of Florida, Gainesville, Fla.; Dr. M. E. MacGillivray, Research Station, Dept. Agric., Fredericton, N. B., Canada; Dr. F. W. Quednau, Forest Research Laboratory. Sillery (Quebec), P. C., Canada. Ants were identified by Dr. David R. Smith, Ent. Res. Div., ARS, USDA, Washington D. C. Dr. Stanwyn G. Shetler, Department of Botany, U. S. National Museum, Washington, D. C. has again kindly made several identifications of plants.

To all of the above, those who made collections and to those who made determinations, I extend my sincere thanks for their help.

Dr. John B. Schmitt, Department of Entomology, Rutgers University, New Brunswick, N.J. has been kind enough to oversee the preparation of the final typescript of this paper.

CEIR—References so cited are frequent throughout the text. It is the commonly used abbreviation for USDA Cooperative Economic Insect Report, issued weekly by the Plant Pest Control Division, ARS of the department.

MT used throughout the text means Moericke Trap. This is a yellow, water-pan or tray which attracts flying aphids.

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[1] Mail address: 2480 16th St., N.W., Washington, D. C. 20009.

NEW YORK ENTOMOLOGICAL SOCIETY, LXXIX: 62–83. June, 1971.

LIST OF APHIDS*

* An asterisk (*) indicates the aphid is an addition to previous papers.

Acyrthosiphon pisum (Harris) Pea Aphid. Recoveries of the braconid parasite, *Aphidius smithi* Sharma & Rao, were made subsequent to its release at Mt. Holly. The next recoveries in New Jersey were in the fall of 1965 at Moorestown, Rancocas, and Vail. (G. W. Angalet and L. W. Coles *in* J. Econ. Entomol. **59**:769–770, June 1966). "Very heavy in alfalfa near Cranbury," (CEIR, **17**(25):534, June 23, 1967); "Although the pea aphid buildup [on alfalfa] during June in New Jersey was heavier than during the past two seasons damage was very light," (Summary of Insect Conditions in 1967 *in* CEIR, **18**(9):415, May 19, 1968). "New Jersey—One per sweep common in most alfalfa May 8," (CEIR, **18**(20):415, May 19, 1968). The following paragraphs pertinent to the pea aphid in New Jersey are taken from the unpublished quarterly reports (kindly made available to me) of the Insect Identification and Parasite Introduction Research Branch, Entomol. Res. Div., ARS, USDA for 1968:

From late Jan. through Feb. the pea aphid was found in very small numbers in the duff collected in alfalfa fields at Moorestown by means of a specially designed duff collector, (Report for the First Quarter).

"The pea aphid was not abundant this year in alfalfa survey fields through mid-June in New Jersey and Delaware. In fact, the aphid has not been sufficiently abundant to cause economic damage to alfalfa during the spring in New Jersey and Delaware during 1966, 1967, and 1968 with the exception of a field near Rancocas, New Jersey during 1966. Previous to 1966 the pea aphid was often reported as causing severe economic damage in alfalfa fields. We find it difficult to obtain data which explains why the population of this pest has been consistently low in fields during the past three years," (Report for the Second Quarter).

"Pea aphid was present throughout the quarter in all of the fields surveyed even though rainfall was considerably below normal. Populations were low to medium until late September when a rapid increase in pea aphid populations occurred in central New Jersey. At Hightstown, N.J. (Mercer County) two alfalfa fields were surveyed on September 23, at which time the pea aphid population averaged 2.1 aphids per six inch plant tip; about equal to 600 aphids per sweep with a standard insect net. At Rancocas, N.J. (Burlington County) aphids averaged in two fields approximately 150 per sweep. Sampling of twelve other fields in Burlington and Mercer Counties, N.J. showed that the buildup of pea aphid in late September was widespread," (Report for the Third Quarter).

"The large buildup of pea aphid populations in Mercer and Burlington Counties, New Jersey, mentioned in the last quarterly report, were controlled by the end of October largely by parasites. Diseased aphids were abundant until mid-October but only a few were found by the end of the month which contained mycelium of *Entomophthora aphidis.* Parasitization of pea aphids was low during September in the alfalfa fields where heavy pea aphid populations occurred. By the end of October, however, 81 to 95% of the full grown aphids examined in 12 fields in Burlington and Mercer Counties were parasitized. The pea aphid population had decreased from an average of 20.3 aphids per six-inch alfalfa stem tip on September 30 to 0.12 aphids per six-inch stem. This decline of population approximates a drop from 600 aphids per sweep with a standard insect net to 3 aphids per sweep. The parasite responsible for the control of the aphid was *Aphidius pulcher*; *Praon* accounted for less than 1% of the parasite mumies collected; and *Aphidius smithi* emerged from only 3 of several thousand mumies collected in Burlington and Mercer Counties. Little buildup of predator populations occurred due to rapid reduction on host populations during October by other biocontrol factors," (Report for the Fourth Quarter).

Reference should be made to the following paper now in press with the Journal of Economic Entomology: "Notes on the spotted alfalfa aphid and the pea aphid in New Jersey, Delaware, and the Eastern Shore of Maryland," by G. W. Angelet, Entomol. Res. Div., ARS, USDA.

Acyrthosiphon (*Rhodobium*) *porosum* (Sanderson), Yellow Rose Aphid. Ridgewood, June 1966, 1 aptera on rose (DDl coll).

Acyrthosiphon solani (Kaltenbach), Foxglove Aphid. Haddonfield, 7–12 June 1967, 3 apterae and 13–22 June 1967, 4 alatae in MT (MDL coll). New Brunswick, 11 Aug. 1959, 1 aptera, 1 alata on potato (H. E. Wave coll & det). Omitted from previous papers. Moorestown, 13 June 1967, 1 aptera in with a number of *Aphis fabae* on rhubarb (HWA coll); 10 June 1967, 12 alatae, nymphs on *Hydrangea* sp. (JAS coll LMR det). Glen Rock. The following records are based on collections made by Mrs. W. Graham Rendell, 121 Boulevard, who is a well-known grower and hybridizer of orchards and other tropical flowering plants in her home. Presumably only three of the plant genera herein recorded have ever been mentioned as host plants for aphids. 16 Nov 1967 and Feb 1968, 2 apterae, 10 nymphs on flowers of *Gesneria cuneifolia.* Standardized Plant Names gives *Gesneria* as a synonym of *Corytholoma* and *Naegelia* but *cuneifolia* is not included in these; 24 Oct 1967 a light infestation on flowers of *Columnea* vars. "Oriole" and "Golden Dragon"; 15 Nov 1967, 3 apterae on *Columnea* hybrid "Betty Stocker"; 16 Nov 1967, 20 apterae, 2 nymphs on flowers of *Hypocerta wettsteinii*; 15 Nov 1967, 10 apterae, nymphs on leaves of *Corytholoma* (*Rechsteineria*) *verticillata*; Mar 1968, 10 apterae, nymphs on buds of the orchids *Leliocattleya luminosa* (SPN gives *Epidendrum aurantiacum* and *Lc. truffautiana*); Sept 1968 a number of apterae, nymphs on *Columnea* hybrids "Rongo" and "Butterfly"; 14 Nov 1968 about 40 apterae, nymphs on *Gloxinia* hybrid (an intergeneric hybrid between *Siningia* and *Rechsteineria*), the plant grown indoors under luminescent light; Dec 1968 a few apterae, nymphs and 1 alata on *Streptocarpus rexii* hybrid.

Attention should be called to the following excellent publication, "Biology of the foxglove aphid in the Northeastern United States" by H. E. Wave and W. A. Shands, ARS USDA Tech Bull No. 1338 in cooperation with the Maine and New Jersey Agricultural Experiment Stations, 40 pp., July 1965. Information on this aphid in New Jersey is contained on pp. 29–31.

Amphorophora crataegi (Monell), Four-spotted Hawthorn Aphid. Green Brook, Hunterdon County (B and F Landscape Co.) 18 September 1968, a number of apterae, nymphs on leaves of *Crataegus crusgalli* (Stinson coll). Third record for N.J.

Aphis asclepiadis Fitch. Moorestown, 10 Oct. 1964 on *Apocynum cannabinum* and 30 Oct 1964 on milkweed (L. W. Coles coll). Omitted from previous paper.

**Aphis cephalanthi* Thomas. Browns Mills, 1 July 1966 on *Cephalanthus occidentalis* (L.L. Pechuman coll). First record for N.J. since the record in preliminary list on *Impatiens* refers to *impatientis*.

Aphis coreopsidis Thomas. A letter dated 18 July 1966 from Dr. L. L. Pechuman states, "I noticed this aphid on *Nyssa sylvatica* on July 1 at Browns Mills. They were on both small and medium sized trees throughout the Browns Mills area; in several cases they were so abundant that the trees were dripping with honeydew." Haddonfield 18 June 1966, scarce on a large *Nyssa sylvatica* (MDL and DLW coll).

Aphis craccivora Koch, Cowpea Aphid. Wayne, 19 July 1966 a heavy infestation on *Caragana arborescens pendula* in a nursery (Conlon coll). Somerset, 20 June 1966 on bittersweet, many apterae (N.J. Dept. Agr. ?Stinson coll). Moorestown, 10 July 1967 on *Robinia pseudoaccacia*, 21 alatae, apterae, nymphs (JAS coll). Princeton, 11 July 1967 on *Sophora japonica* (N.J. Dept. Agr. coll LMR det); 5 July 1967 a heavy but scattered infestation on *Cladrastis lutea*, Yellowwood. (N.J. Dept. Agr. coll).

Aphis fabae Scopoli, Bean Aphid. Atlantic County summer of 1966 a heavy infestation on new leaves of *Euonymus* ap. (Junghans coll). "Light to moderate on beans in Cape May and Cumberland Counties," (CEIR, **17**:764, 18 Aug. 1967). Ridgewood, 19 June 1966 numerous on mockorange (DDL coll). "Increasing on beans in southern counties," (CEIR, **17**(30):677, July 1967). Moorestown, 13 June 1967 on rhubarb (HWA coll). Delaware Water Gap 21 June 1967, 1 alata, about 30 aptera collected from *Polygonum* sp. and attended by the ant, *Crematogaster lineata* (Say), (W. H. Day coll). "Curling young bean leaves in several Cape May County fields," (CEIR, **18**:732, 2 Aug. 1968).

Aphis gossypii Glover. Cotton Aphid. Hackensack (Home Nursery) 14 June 1966, a heavy infestation on terminal shoots of *Althea rosea* (Conlon coll). Upper Montclair (Paul F. Sachs Nursery) on tips of flowerstems of *Hesperis matronalis*; infestation moderate since many plants had been sprayed (Conlon coll). Moorestown 14 June 1967 heavy on terminals of rose-of-sharon but most specimens dead (MDL & JAS coll); 13 June 1967 a number from *Vaccinium corymbosum* (HWA coll MDL and LMR det to "near" *gossypii*); 14 June 1967 many alatae and a very few small nymphs on *Forsythia* sp. (MDL & JAS coll MDL det with query).

Aphis hederae Kaltenbach, Ivy Aphid. Haddonfield, a very few were found on 12 June 1967 but examination of several small plantings later that year and several times from spring to fall in 1966 and 1968 failed to reveal the presence of this aphid on English ivy. (MDL).

Aphis helianthi Monell. Moorestown, summer 1967, in EAR's garden, a light infestation on *Helianthus annuus* (MDL coll). In Plant List of previous paper but record omitted from the text.

Aphis pomi DeGeer, Apple Aphid. Haddonfield 20 June 1967 abundant and curling the leaves of a fair sized bush of *Chaenomeles speciosa* and attended by many ants, *Crematogaster cerasi* (Fitch), (MDL coll); 2 Nov 1968 a very few alatae and nymphs on the same plant (MDL). South Bound Brook 30 June 1966 a medium infestation on flowering crab (Stinson coll).

Millington, Somerset Co. (Long Hill Nursery) 28 June 1966, heavy on tips of crabapple (Sayer coll). "Infestations damaged sucker growth [apple] in Southern New Jersey until controlled in the early summer. This species was more abundant in 1967 than in past years," (Summary of Insect Conditions—1967 *in* CEIR, **18**(11):192, 15 Mar 1968). "Difficult to find in orchards Statewide," (CEIR, **18**(24):522, 14 June 1968). "Curling sucker leaves in unsprayed apple blocks," (CEIR, **18**(26):588, June 28, 1968). Greenbrook, Somerset Co., 20 June 1967 heavy infestation of apterae on terminals of *Cotoneaster* sp. (Stinson coll). Moorestown, 13 June 1967, several alatae, apterae, nymphs on *Chaenomeles japonica* (HWA coll). Freehold, Monmouth Co., (Bobbink Nurseries, Inc.), 26 July 1968 a light infestation on leaves of *Malus atrosanguinea*: 25 July 1968, a light infestation on *M. purpurea "eleyi"*; 29 July 1968 a heavy infestation on leaves and stems of *M. hopa*; 30 July 1968, a light infestation on leaves and stems of *Sorbus americana* (all Griner, Dept. Agr. coll).

Aphis rumicis Linnaeus, Dock Aphid. Ridgewood 29 June 1967 abundant in curled leaves of a large *Rumex obtusifolia* (MDL and DDL coll).

Aphis spiraecola Patch, Spiraea Aphid. Trenton 23 Aug 1966 light on tips of *Spiraea bumalda* var. Anthony Waterer (Stinson coll). South Orange, 24 June 1966 heavy on tips of *Pyracantha* sp. (Stinson coll). Haddonfield 8 June 1966 the terminal shoots of a small planting on bridalwreath *Spiraea* encrusted with aphids but by 10 days later almost all had disappeared (MDL); 10–21 June 1966 a light infestation was present on a few terminals of *Pyracantha* sp. (MDL) attended by the ants *Crematogaster cerasi* (Fitch) and *Lasius neoniger* Emery; 24 Apr 1968 a small planting of *Spiraea vanhouttei* had a few tender tips lightly infested (MDL). Paramus, Bergen Co. 14 June 1967 light on

Pyracantha sp. (Conlon coll). Moorestown 10, 13 June 1967 a very few on *Pyracantha* sp. (HWA); 10 June 1967 many, all stages on red horticultural plum (JAS coll LMR det). Mendham 15 June 1967 heavy on tips of *Spiraea vanhouttei* (NJ Dept. Agr. coll). Neshanic, Somerset Co. 16 June 1967 a light infestation on *Pyracantha* sp. (Stinson coll). Freehold, Monmouth Co., 30 July 1968 a light infestation on leaves and stems of *Spiraea thunbergii* (Griner coll). Rake Pond, 20 June 1966 several alatae on *Lyonia* (*Pieris*) *mariana* (Marucci coll LMR det). Previously recorded as actually occurring on this plant.

Brachycaudus cardui (Linnaeus), Thistle Aphid. Ridgewood June 1966 on thistle (DDL coll) attended by the ant, *Penolepis imparis* (Say).

Branchycaudus persicicola (Boisduval), Black Peach Aphid. (Formerly *Anuraphis persicaeniger* Smith) As *Myzocallis caryaefoliae* "Killed several peach trees in each of two plantings in New Jersey," (Summary Insect Conditions—1966 *in* CEIR, **17**(13):230, 21 March 1967). *In* CEIR, **17**(16):318, 21 Apr 1967 the name of the aphid was corrected to read "the black peach aphid, *Brachycaudus persicicola* (Boisduval)." "Reported in several Camden County blocks of newly planted fruit [peach] trees," (CEIR, **17**(17):346, April, 28, 1967). "Killed several nonbearing trees [peach trees] in one Camden County orchard," (CEIR, **18**(11):193, March 15, 1968).

Brevicoryne brassicae Linnaeus, Cabbage Aphid. "This species and *Myzus persicae* increasing on crucifers in central and southern counties," (CEIR, **18**(40):945, Oct 4, 1968). Haddonfield, 22–24 Oct 1968, 4 alatae in MT (MDL).

**Calaphis* n. sp. Haddonfield, 16 June 1967, 1 alata in MT (MDL coll Quednau det).

**Calaphis* n. sp. Quednau in MS. Haddonfield, 14 April 1968 (MDL coll) and June 1968 (DLW coll—Quednau det) on *Betula populidolia.*

**Calaphis alni* Baker. Haddonfield, 16 June 1967, 1 or 2 alatae in MT (MDL coll—Quednau det).

Calaphis betulella Walsh. Haddonfield, 16 June 1967, 1 or 2 alatae in MT (MDL coll Quednau det); 15 June 3 alatae; 17–18 June 3 alatae; and 19–22 June 1966, 3 alatae in MT (MDL coll); 13–22 June 1967, 2 alatae in MT (MDL).

Capitophorus elaeagni (DelGuercio), Oleaster Thistle Aphid. Haddonfield, 15 July 2 alatae and 16 June 1 alatra 1966; 7–12 June 1967, 8 alatae; 13–22 June 1967, 10 alatae and 22–24 Oct 1968 all in MT and MDL coll.

Capitophorus hippophoes (Walker), Polygonum Aphid. Haddonfield, 16 June 1966, 2 alata in MT (MDL). Cranbury, 11 July 1967, 1 alata in MT in potato field (DeBlois coll).

Chaitophorus sp. Indian Mills, 26 May 1963 on *Salix* sp. (HWA coll—MacG det). Cranbury, 24 July 1967, 1 alata in MT in potato field (DeBlois coll).

Chaitophorus viminalis Monell, Little Black and Green Willow Leaf Aphid. Haddonfield, 13–22 June 1963, 1 alata in MT (MDL coll-Quednau det).

Chromaphis juglandicola (Kaltenbach), Walnut Aphid. Moorestown, 22 July 1967, 19 alatae, 3 "pupae"; and 14 Aug 1967, 5 alatae, 7 "pupae" on *Juglans regia*; 29 Aug 1967, 3 alatae, 1 "pupa," 12 nymphs on *Juglans nigra* (all EAR coll—TLB det).

?*Cinara braggii* (Gillette). Somerville (M T M Nurseries), 17 June 1966 on tips of *Picea* sp. (Stinson coll JOP det with query).

**Cinara carolina* Tissot. Browns Mills, Burlington Co., 8 June 1968 alatae, apterae on *Pinus rigida* (L L Pechuman coll JOP det). Pepper and Tissot are of the opinion that *carolina* is identical with Wilson's *atlantica*.

**Cinara cupressi* (Buckton). Hess' Nursery, Wayne, Passaic Co., 5 May 1966 on *Juniperus scopulorum* (Blue Haven), Rocky Mountain Juniper grafts *J. virginiana* was used as root-stock. About 2000 plants were in a greenhouse. Conlon states the aphids had been numerous but had been sprayed with lindane just before he arrived. (Conlon coll ANT and JOP det).

Cinara pilicornis (Hartig) Pemberton 24 May 1939 on *Picea* sp. (Wm. J. Haudé coll ANT det with query). Omitted from previous lists. Haddonfield, 17 June 1966 many on a Norway spruce (MDL and DPL coll ANT det). A number of mirrid bugs, *Microphyllelus* sp. (det. Froeschner) were associated with this aphid. *M. modestus* Reuter has been recorded as occurring with aphids on elm and feeding on their honeydew (Knight *in* Ill. Nat. Hist. Surv. Bull., **22**, p. 41, 1941). Additional specimens were present on the same tree in the summer of 1968 (DLW coll).

Cinara pinea (Mordwilko). Clark (Zdanovich Nursery), 6 June 1966 light to medium on tips and bark of *Pinus* spp. (Conlon coll JOP det).

Cinara pinicola Kaltenbach. "Occurs on spruce in the Appalachian Highlands area." (N J Prelim List under *Cinara abietis* (Fitch).

Cinara strobi Fitch, White Pine Aphid. W. V. Griffin Nurseries, Heege Farm, Middlesex Co., ?1967, 9 apterae on *Pinus strobus* (Addison Driver Coll—MDL det).

**Cinara tujafilina* (DelGuercio), Arborvitae Aphid. New Jersey, Intercepted at USDA Plant Quarantine in New York City by Inspector R Day 26 June 1968, 9 apterae, nymphs on arborvitae (LMR det).

**Cinara watsoni* Tissot. Red Lion, Burlington Co., 8 June 1968, apterae only on *Pinus rigida* (L L Pechuman coll JOP det) and Chatsworth, Burlington Co., 10 June 1968, apterae on *P. rigida* (L L Pechuman coll JOP det).

Cinara sp. Allendale, 13 June 1967 light on *Picea pungens* (Conlon coll—MDL det).

Coloradoa rufomaculata (Wilson), Pale Chrysanthemum Aphid. Moorestown, 10 June 1967 a few alatae, apterae on cultivated chrysanthemums (HDA coll).

Dactynotus sp. Haddonfield, 24–27 July 1965, 18 alatae in MT (MDL coll ATO det).

Dactynotus sp. Moorestown, 9 Sept 1967, about 50 alatae, apterae on Gloriosa Daisy (EAR coll).

Dactynotus ambrosiae complex. Chester 3 Aug 1959 on *Erigeron* sp. (H E Wave coll ATO det 20.VII.66). Haddonfield, 16–18 June 1966 alatae in MT (MDL coll).

Dactynotus erigeronensis (Thomas), Canadian Fleabane Aphid. Moorestown, Sept 1965 on *Erigeron canadensis* (Roger Fuester of USDA coll). Haddonfield, 18 June 1966 on *E. annuus* and 2 collections on *E. canadensis* (MDL and DLW coll).

Dactynotus gravicornis Patch. Moorestown, Sept 1965 on *Erigeron canadensis* (Roger Fuester of USDA coll). Haddonfield, 18 June 1966 on *E. annuus* (MDL and DLW coll).

Dactynotus leonardi Olive. Moorestown, 24 Aug 1965 on *Rudbeckia hirta* (EAR coll). Ridgewood, 24 Aug 1968, about 25 alatae, apterae, nymphs from *Rudbeckia hirta* (DDL coll).

Dactynotus nigrotuberculatus Olive. Haddonfield, 17–18 June 1966 alatae in MT (MDL coll). Ridgewood, 20 May 1965 on *Solidago* sp. (DDL coll). Moorestown, 30 June 1965 many on *Solidago* sp. (HWA coll).

Dactynotus paucosensoriatus Hille Ris Lambers. Moorestown, 6 Oct 1964 on *Aster* sp. (EAR coll).

Dactynotus sonchellus (Monell). Haddonfield, 18 June 1966 on *Lactuca* sp. (MDL and DLW coll).

Dactynotus tissoti (Boudreaux). Haddonfield, 13–22 June 1967, 2 alatae in MT (MDL coll Quednau det).

Eriosoma americana (Riley), Woolly Elm Aphid. Burlington County, 10 June 1947 accidental on blueberry (W E Tomlinson coll 1 slide in USNM).

Eriosoma crataegi (Oestlund). Pennington, Mercer Co. (Howe's Nurseries), 7 Aug 1968 a number on stems of *Crataegus crusgalli* (Stinson coll).

Eucallipterus tiliae (Linnaeus), Linden Aphid. (Formerly in *Myzocallis*.) Haddonfield, 19–22 June 1966, 1 alata in MT (MDL coll). Moorestown, 14 Aug 1967, a very few on *Tilia cordata* (EAR coll).

**Euceraphis deducta* Baker. Haddonfield, 14 Apr 1968 a fair infestation just starting on a small yellow birch in back yard of 217 Rhoads Ave. (MDL coll Quednau det). First record for New Jersey.

Euceraphis lineata Baker. Haddonfield, June 1968, 1 alata, 1 aptera in with a number of *Calaphis* n. sp. Quednau on the yellow birch at 217 Rhoades Ave. (DLW coll Quednau det). Second record for New Jersey.

Euceraphis mucida (Fitch). Haddonfield, 1 sexupara, 2 alate males in MT 22–24 Oct 1968 (MDL coll Quednau det). Second record for New Jersey.

**Fimbriaphis* sp. Mr. P. E. Marucci wrote me as follows on 6 March 1969: Hammonton, 26 May 1966 "Aphids collected on blueberries were so numerous throughout an entire field of twenty acres of the Weymouth variety that stunting of foliage was occurring and the field had to be sprayed with parathion for control. This was the first instance in eighteen years in which I have observed economic damage inflicted on blueberries by aphids. A correspondent in Connecticut experienced damaging aphid population in cultivated blueberries in 1964. In both instances the use of sevin instead of malathion to control blueberry maggot the previous year was probably responsible. This vial had more than 100 aphids, including alatae. It was determined by Miss Louise Russell as *Fimbriaphis* sp. with the following note: specimens differ from the types of *scammelli* (Mason) which has been transferred from *Myzus* to *Fimbriatus*. (This was done by Richards). Chatsworth, 24 May 1966 2 nymphs on cranberries (Marucci coll LMR det) and a single aphid on cultivated blueberries Folsom, 10 May 1966 (Marucci coll LMR det as *Myzus* sp. prob *scammelli*).

***Glabromyzus howardii* (Wilson), Poison Ivy Aphid. Jobstown, 7 June 1966 a number of apterae on poison ivy (Leon W. Coles coll). The record in the "Preliminary List" from Ridgewood, May 1938 on poison ivy under *Rhopalosiphum rhois* Monell belongs here.

Hyadaphis foeniculi (Passerini), Honeysuckle and Parsnip Aphid. (Formerly *Phopalosiphum conii* (Davidson.) Moorestown, 14 June 1967 heavy on terminals of *Lonicera* sp. (MDL and JAS coll—LMR det).

Hyalopterus pruni (Geoffroy), Mealy Plum Aphid. Princeton, 13 July 1967 a heavy infestation on *Prunus blireiana* (Stinson coll).

***Izyphya flabella* Sanborn. Haddonfield, 16 June 1966, 1 alata in MT (MDL coll).

Kakimia essigi Gillette & Palmer, Black-backed Columbine Aphid. Moorestown, 13 June 1967 on *Aquilegia* sp. (HWA coll).

Longistigma caryae (Harris), Giant Bark Aphid. "Common on oaks in central and southern counties." (CEIR, **17**(41):927, 13 Oct 1967. Colts Neck, 15 Nov 1967 a light infestation on oak twigs (G Pope coll). Moorestown, Sept 1967 on basswood (R W Fuester of USDA coll). "Heavy on oak during the fall in central and northern New Jersey." (Summary of Insect Conditions—1967 *in* CEIR, **18**(13):249, 29 March 1968).

Macrosiphoniella sanborni (Gillette), Chrysanthemum Aphid. Woodcliff Lake, 10 June 1967 light on new growth of cultivated chrysanthemum (Conlon coll).

?*Macrosiphoniella tanacetaria* (Kaltenbach). Ridgewood, 24 Aug 1968 on "Painted Daisy" or "Pyrethrum" (may be *Chrysanthemum coccineum*) about 25 nymphs and a few apterae (DDL coll).

Macrosiphum sp. Haddonfield, 28 Aug-2 Sep, 9 alatae and 24–27 Sept 1965, 9 alatae in MT (MDL coll ATO det).

**Macrosiphum californicum* Essig. Ridgewood, 9 June 1968, 1 alatae, 8 apterae, nymphs on *Salix discolor* and 7 July 1968, 6 apterae on same tree (DDL coll).

Macrosiphum euphorbiae (Harris), Potato Aphid. Moorestown, 30 Oct 1964 on milkweed and 20 Oct 1964 on *Apocynum cannabinum* (Leon W Coles coll); 15 June 1966 scarce on many *A. cannabinum* plants (MDL coll); 13 June 1967 a few on *Aquilegia* sp. (HWA coll); 14 June 1967 2 apterae on *Chaenomeles japonica* (MDL and JAS coll); 22 June, Aug 1967 alatae, 1 small nymph on *Datura* sp. (W H Day coll); 10 June 1967 several alatae, apterae, nymphs on *Apocynum androsaemifolium*, 1 aptera on *Philadelphus inodorus*, 14 aptera, alatae on *Aster* sp., 30 alatae, aptera, nymphs on *Rosa* sp., and 13 alatae, apterae, nymphs on *Lactuca alba*, 9 Oct 25 alatae, apterae, nymphs on winter squash all 1967, JAS coll LMR det; 14 June 1967 quite a few on tender growth of *Hydrangea* sp. both green and pink forms present (MDL and JAS coll) a number parasitized by *Aphidius nigripes* (Ashmead) Paul Marsh det. Haddonfield, 2 May 1936 many apterae on cult rose (MDL and DPL coll); 18 June 1966 moderate on several *Apocynum cannabinum* (MDL); 15–16 June 1966, 6 alatae in MT and 13–22 June 1967, 4 alatae in MT (MDL). Ridgewood, June 1966, 1 aptera on cult rose (DDL coll); 25 June 1967 a few nymphs on *Dicentra* sp. (DDL coll LMR det). Bound Brook, Ivy Hill Gardens, 22 June 1966 light on *Iris* sp. (Stinson coll). Delaware Water Gap, 21 June 1967, 1 alata on *Solanum carolinense* (W H Day coll). Glen Rock, July 1968, 1 alata, about 65 apterae, nymphs on buds and blooms of a single rose plant (Marion Rendell coll). Waterford, 8 Aug 1967, 4 alatae in MTs in a strawberry field (DeBlois coll). Cranbury, 11 July 1967, 6 alatae, and 18 July, 1967, 7 alatae in MTs in potato fields (DeBlois coll). "Very abundant on tomatoes throughout the State." (CEIR, **17**(25):539, 23 June 1967). "Light to moderate on tomatoes in southern counties." (CEIR, **17**(29):650, 21 July 1967). "Eggs more abundant than during same time in 1966. Percent viable eggs averaged 61.1 compared with 33.5 in 1966." (CEIR, **17**(13):220, 31 March, 1967). "Populations in New Jersey were heavy and injury moderate on tomatoes and potatoes early in the season but numbers were very light on eggplant and peppers." (Summary of Insect Conditions in 1967 *in* CEIR, (**18**(10):161, 8 March 1968). "Light to moderate in most tomato fields." (CEIR, **18**(25):551, June 21, 1968). "Troublesome in many tomato fields Statewide." (CEIR, **18**(26):584, 28 June 1968). Ridgewood, 15 July 1967, 1 alata, 2 nymphs, 1 "pupa" on *Lithospermum* sp. (DDL coll in his garden). Swedesboro, 5 May 1967, a considerable number on *Asparagus officinalis* (JAS coll LMR det).

The potato aphid egg survey was continued during the 3-year period on the swamp rose, *Rosa palustris*, by the N. J. Dept. Agr. with the following results:

Average percentage of viable eggs found per site per county:

County	1966	1967	1968
Burlington	23.1	45.1	50.2
Cumberland	14.7	28.5	27.0
Gloucester	6.6	19.8	94.8
Mercer	15.6	47.0	58.0
Middlesex	19.0	78.0	25.0
Monmouth	25.0	64.0	31.0
Salem	5.3	36.8	25.0
State Average	33.5	61.1	79.4
Total No. Eggs	421	1007	1420

Results of the 1969 survey made 8 Jan-24 Jan have recently become available so are here included:

County	No. sites surveyed	No. potato aphid eggs
Burlington	6	129
Cumberland	2	17
Gloucester	5	367
Mercer	4	68
Monmouth	3	69
Salem	4	62
Totals	24	712

Percent viable eggs 62.1

Macrosiphum gaurae* (Williams). In "A Preliminary List of the Aphids of New Jersey" (J. N.Y. Entomol. Soc., **64:110, 1956) Leonard recorded *M. pseudorosae* Patch from *Oenothera* sp. Sept 1946 from Haddonfield. Dr. M. E. MacGillivray *in* Ann. Entomol. Soc. Amer., **61**:353, 1968 states that the specimen on which this record is based is *gaurae.*

Macrosiphum liriodendri (Linnaeus), Tuliptree Aphid. Haddonfield, 18 June 1966 a large tuliptree heavily infested (MDL and DLW coll). Red Lion, Burlington Co., 1 July 1966 on *Magnolia virginiana* (L L Pechuman coll). Moorestown, 14 July 1967 a few on tuliptree (EAR coll). Freehold, Monmouth Co., 2 Aug 1968, a light infestation on tuliptree (Griner coll).

Macrosiphum rosae (Linnaeus), Rose Aphid. Ridgewood, 14 June 1967 on rose attended by the ant, *Prenolepis imparis* (Say), (DDL coll); Ridgewood, 25 June 1967 abundant on cult rose on one terminal shoot (MDL coll); 9 June 1968 several alatae, apterae on Blaze rose (a climber) and on Dorothy Perkins Crimson Rambler and a few wingless on Floribunda rose (DDL coll); June 1966 numerous on cultivated roses (DDL coll). Clark 6 June 1966 light in roses (Conlon coll). Haddonfield, 8–12 June 1967, 2 alatae in MT (MDL coll). Riverton, 1 Oct 1967 many on cultivated roses (B Townshend coll thru W H Day). Cherry Hill, 13 June 1967, 2 alatae, 3 apterae on Burford holly (HWA coll). Moorestown, 12 June 1966 moderate on cultivated roses (MDL and W E Flemming coll); 14 June 1967, 17 alatae, 12 apterae on *Buxus* sp. (MDL and JAS coll); 6 Jan 1966, 3 apterae and several very young on rose cuttings indoors (EAR coll); 10 June 1967, 5 alatae on cult rose (JAS coll LMR det). Glen Rock, July 1968 a few apterae, nymphs on rose blooms (Marion Rendell coll).

**Masonaphis pepperi* MacGillivray. New Lisbon, 16 May 1966 on blueberry many aphids collected in greenhouse; 11 specimens on a slide, alatae, apterae, nymphs, in USNM (Marucci coll LMR det).

**Masonaphis* (*Masonaphis*) *rhokalaza* Tissot and Pepper. Red Lion, Burlington Co., 30 June 1966 on *Rhododendron viscosum* (L L Pechuman coll MacG det). Woodcliff Lake, 10 July 1967 light on new growth of *Rhododendron* sp. (Conlon coll).

?*Masonaphis* sp. Rake Pond, 20 June 1966, 5 nymphs on *Gaylussacia frondosa* (Marucci coll LMR det as "apparently *Masonaphis* sp.").

Melanocallis caryaefoliae (Davis), Black Pecan Aphid. (ESA's List of Official Common Names places this in *Myzocallis*. Richards places it in *Tinocallis*). Ridgewood, 17 May 1936, 1 alata on hickory (MDL coll). Haddonfield, 16 June 1967, 1 or 2 alatae in MT (MDL coll Quednau det).

Monellia costalis (Fitch), Black-margined Aphid. This species has a single record in my "Preliminary List of New Jersey Aphids" (J. N. Y. Entomol. Soc., **64**:112, 1956) from Ridgewood, July 1936 on *Quercus* sp. In October 1966 I happened to look at the slides upon which this record was based and was surprised to find that I had misidentified them. They were sent to Dr. A. N. Tissot who determined them as a mixture of *Myzocallis walshii* (Mon.) and *M. multisetis* B. and T. (See data under these species). *M. costalis* was not collected in New Jersey until 1947 and again in 1963 (Leonard's "Further records of New Jersey aphids *in* J. N. Y. Entomol. Soc., **75**:85, 1967).

Monelliopsis caryae (Melell), American Walnut Aphid. (In previous lists under *Monellia*). Moorestown, 14 Aug 1967, several alatae, 1 "pupa" on *Juglans nigra* (EAR coll TLB det).

Myzocallis discolor (Monell), Eastern Dusky-winged Aphid. Haddonfield, 19–22 June 1966, 2 alatae in MT and 7–12 June 1967, 2 alatae in MT (MDL coll).

Myzocallis multisetis Boudreaux and Tissot. Ridgewood, 4 July 1936, alatae, nymphs mixed with those of *M. walshii* on *Quercus* sp. (MDL coll ANT det).

Myzocallis punctata (Monell), Clear-winged Oak Aphid. Haddonfield, 16 June 1 alata and 17–18 June 1966 1 alata (dark form) and 19–22 June 1966, 3 alatae in MT (MDL coll). Cranbury, 11 July 1967, 1 alata in MT in potato field and Waterford, 8 Aug 1967, 1 alata in MT in strawberry field (DeBlois coll).

Myzocallis tiliae (Linnaeus), (see *Eucallipterus tiliae* L.).

Myzocallis walshii (Monell). Ridgewood, 4 July 1936 alatae, nymphs mixed in with *M. multisetis* B and T (MDL coll ANT det).

Myzus cerasi (Fabricius), Black Cherry Aphid. Haddonfield, 11 June 1967 many on water-sprouts of a cherry (MDL and DLW coll); attended by many ants, *Prenolepis imparis* (Say).

?*Myzus certus* (Walker). New Brunswick, 5 Apr 1959 on *Stellaria media* (H E Wave coll det V F Eastop who states this is in the *certus* group and is probably *certus* but is not *persicae*).

Myzus persicae (Sulzer), Green Peach Aphid. "Incidence of this aphid in New Jersey was abnormally high owing to shortage of normal weed hosts because of the prolonged drought and subsequent migration of alates to irrigated crops during midsummer and late summer. Potatoes, tomatoes, peppers, and other crops were damaged (p. 179). Incidence was abnormally high in lettuce and other crops were damaged." (p. 190). (Summary of Insect Conditions in New Jersey—1965, *in* CEIR, **16**(10):179, 190, March 11, 1966). "Green peach aphid was significantly less abundant than in 1965 on tomatoes, peppers and potatoes in New Jersey." (Summary in Insect Conditions—1966, *in* CEIR, **17**(12):206, 24 March 1967). "Green peach aphid was significantly less abundant than in 1965 on cruciferous crops in New Jersey, probably due to extremely hot weather during early July." (*Ibid*, p. 210). "Light to moderate on eggplant in Essex, Warren and Burlington Counties; on tomato thruout State." (CEIR, **17**(31):705, 4 Aug 1967). "Light to moderate on crucifers near Fairfield, Essex Co." (*Ibid*, p. 706). "Extremely abundant on peach trees in central and southern counties. Winged adults indicate impending migration to summer host plants; need for control doubtful." (CEIR, **16**(23):517, 1966). "Winged and young forms noted in Cape May County on eggplant." (CEIR, **16**(32): 782, 12 Aug 1966). "Light to moderate on peppers and tomatoes in central and southern counties." (CEIR, **16**(33):808, 19 Aug 1966). "Appearing on escarole and early endive." CEIR, **17**(26):567, 30 June, 1967. "Increasing on pepper near Elm, Camden Co.; common on tomatoes thruout State." (CEIR, **17**(30):676, 28 July 1967). Haddonfield, 13–22 July 1967, 1 alata in MT (MDL coll); 12 Aug 1967, 3 alatae in MT (MDL coll). Ridgewood, (Schweinfurth's Florists), 24 June 1967, scarce in a greenhouse of carnations (MDL and DDL coll). Moorestown, Aug 1967, 4 alatae on *Datura* sp. (W H Day coll); 10 June 1967, 1 aptera on *Aster* sp. (JAS coll LMR det); 18 Nov 1967, about 60 apterae from a tree tomato, *Cyphomandra betacea*, which had been brought indoors before the first frost; on Feb 1968 the upper surface of the leaves of this plant were still considerably infested (EAR coll). Waterford, 8 Aug 1967, 8 alatae and 22 Aug 1967, 15 alatae in MTs in strawberry fields (DeBlois coll). Cranbury, 11 July, 3 alatae, 9 Aug, 4 alatae, 16 Aug about 50 alatae and 30 Aug, 3 alatae, all in 1967, and in MTs in potato fields (DeBlois coll). Glen Rock, May 1968, about 50 apterae, nymphs from *Hibiscus rosasinen-*

sis indoors (Marion Rendell coll). "Generally less abundant in New Jersey than in recent years although the numbers were moderate on beans throughout 1967." (Summary of Insect Conditions—1967, *in* CEIR, **18**(10):163, March 8, 1968). "Infestations were moderate on lettuce throughout the season." (Summary of Insect Conditions—1967, *in* CEIR, **18**(10):168, 8 March 1968).

Nasonovia ribisnigri Mosley. Moorestown, 12 June 1966 and 16 June 1967 a fair number on upper part of flower-stems of several *Hieracium gronovii* (MDL and W E Flemming coll); 15 June 1966 fairly numerous on upper part of stems and on flower heads of a number of *H. pratense* (MDL and W H Day coll).

Neoceruraphis viburnicola (Gillette), Snowball Aphid. Haddonfield, 19 April, 2 alatae, 22 April, 4 alatae and 21 April, 4 alatae in the MT at 217 Rhoads Ave.; cool weather followed with some rain and no more came to the yellow pan until April 24 when 21 alatae were taken; all of these were spring migrants; a large snowball bush is but a few feet away from the MT; on this many ants were present, *Crematogaster cerasi* (Fitch).

Ovatus crataegarius (Walker), Mint Aphid. Moorestown, 12 Jul 1968, a very few on a small patch of peppermint (MDL and W E Flemming coll).

Pemphigus sp. "Damaged escarole in muck soil near Vienna, Warren Co." (CEIR, **18**(30):701, 26 July 1968. This note was given under *Pemphigus bursarius* (Linnaeus). However specimens were later sent to Dr. Clyde F. Smith who replied that they could not be specifically identified.

Pergandeidia trirhoda (Walker). Ridgewood, 12 Oct 1936 on *Aquilegia* sp., many specimens on 9 slides and Haddonfield, 25 Oct 1936, on *Aquilegia* sp., many specimens on 8 slides (MDL coll). Both records omitted from previous lists.

Periphyllus californicus (Shingi). Harrington Park (Giotta's Nursery), 23 May 1966 on *Acer palmatum dissectum*, 10 plants infested (Conlon coll JOP det).

Periphyllus lyropictus (Kessler), Norway Maple Aphid. Haddonfield, 8 June 1966 fairly abundant on Norway maple street trees on Rhoads Ave. but reported that somewhat earlier infestation had been heavy and considerable leaf-drop had occurred (MDL).

Periphyllus negundinis Thomas, Boxelder Aphid. Haddonfield, 10 June 1966 a large boxelder very lightly infested (MDL).

Phyllaphis fagi (Linnaeus). Haddonfield, 8–22 June 1966 many leaves on the large copper beech at 213 Rhoads Ave. heavily infested (MDL); 18 June 1967 abundant on the same tree (MDL); 16 and 13–22 June 1967, 2 or 3 alatae each in MT (MDL coll Quednau det).

Pleotrichophorus glandulosus (Kaltenbach). (Formerly in *Capitophorus*). Haddonfield, 8–23 June 1966 scarce on a few small patches of *Artemisia vulgaris* (MDL coll).

Prociphilus imbricator Fitch, Beech Blight Aphid. "Beech Blight Aphid heavily infested beech trees in New Jersey during the late summer and early fall." (Summary of Insect Conditions—1967 *in* CEIR, **18**(13):249, 29 Mar 1928).

Rhopalosiphum maidis (Fitch), Corn Leaf Aphid. "In New Jersey high numbers infested sweet corn plantings throughout the season and injury was very noticeable. Aphids on flag leaves and husks reduced the market value." (Summary of Insect Conditions—1967 *in* CEIR, **18**(8):101, 27 Feb 1968). "First of season noted on sweet corn in Cape May County field." (CEIR, **18**(32):753, 9 Aug 1968). "Still troublesome on sweet corn in many areas." (CEIR, **18**(35): 832, 20 Aug 1968).

Rhopalosiphum nymphaeae (Linnaeus), Waterlily Aphid. Saddle River, Bergen Co. (Wm. Tricker, Inc.), 12 July 1967 on arrowhead, lotus, waterlilies, heavy infestation on leaves. (Conlon coll).

Schizaphis graminum (Rondani), Greenbug. Prof. J. O. Pepper wrote me 23 March 1968 that he has slides made from collections made by R. S. Filmer in "NJ" by "sweeping" in 1961 as follows: Oct 6, 1 alata; Oct 9, 1 alata; Nov 6, 2 alatae. Harmony, Warren Co. On 5 Dec 1968 the greenbug was found in a 10–15 acre field of barley; the plants were 6–8 ins. tall. The infestation was reported to be common throughout the field and the older leaves were yellow to white in color. At the same time this aphid was collected from orchard grass on the edge of a wheat field but no aphids were found on the wheat (Harry Surfass, Warren Co. Agr. Agt. coll; specimens transmitted through Stuart R. Race, Ext. Ent., College of Agriculture, Rutgers University). This occurrence on barley is also noted in CEIR, **19**(6):69, 1968. The collection of the greenbug on orchardgrass is only its second known occurrence on that plant in the Atlantic Coast States, the other one being on young orchardgrass seedlings at Clarksville, Howard Co., Md. in 1958. (see U. S. Dept. Agr. Coop. Econ Ins. Rpt **8**(47):953, 1958).

**Stegophylla quercina* Quednau. Ridgewood, 31 May 1936 on *Quercus* sp. (MDL coll Quednau det who wrote 7 Dec 1966 "This record is from a slide given me by the late Prof. E. O. Essig and determined by him as *Phyllaphis fagi* L.").

Therioaphis maculata (Buckton), Spotted Alfalfa Aphid. Mr. L. Donald DeBlois has kindly furnished the results of the New Jersey Department of Agriculture Spotted Alfalfa Surveys. The figure following each date is the number of specimens collected in alfalfa by 300–450 sweeps in 1966 and 250–300 sweeps in 1967 of a 15 inch insect sweep net:

1966—Cumberland Co.: Greenwich 5 Dec. 4; Shiloh 5 Dec. 1. Gloucester Co.: Jefferson 9 Dec. 3; Mullica Hill 9 Dec. 2; Salem Co.: Centerton 6 Dec. 3; Elmer 6 Dec. 3; Quinton 6 Dec. 1; Welchville 6 Dec. 1.

1967—Burlington Co.: Evesboro 8 Nov. 90; Hedding 31 Oct. 1; Mt. Holly 31 Oct. 2; Vincentown 31 Oct. 50. Cumberland Co.: Bacon's Neck 3 Oct. 30; Fairton 3 Oct. 10;

Greenwich 2 Oct. 25; Roadstown 2 Oct. 60; Shiloh 2 Oct. 90; Stow Creek Landing 3 Oct. 100; Woodruff 9 Oct. 15. Gloucester Co.: Bridgeport 17 Oct. 20; Hurffville 6 Nov. 100; Mullica Hill 17 Oct. 100. Monmouth Co.: Allenwood 16 Oct. 1; Clarksburg 16 Oct. 2; Cream Ridge 16 Oct. 2. Salem Co.: Alloway 5 Oct. 50; Centerton 6 Nov. 100; Harmersville 5 Oct. 250; Pole Tavern 9 Oct. 29; Shirley 5 Oct. 600; Welchville 5 Oct. 2.

New Jersey Dept. Agr. Spotted Alfalfa Survey for 1968 during the period 10 Oct to 22 Oct 1968:

County	No. fields surveyed	Infested No. fields	Population Range
Burlington	6	5	0–40 per 100 sweeps
Cumberland	6	6	25–800 per 100 sweeps
Gloucester	6	6	50–150 per 100 sweeps
Mercer	5	5	7–12 per 300 sweeps
Monmouth	5	5	6–17 per 300 sweeps
Middlesex	5	5	1–11 per 300 sweeps
Salem	6	6	50–500 per 300 sweeps
Total	39	38	

The following paragraphs pertinent to the spotted alfalfa aphid are taken from the unpublished (kindly made available to me) quarterly reports of the Insect Identification and Parasite Introduction Research Branch, Entomol. Res. Div., ARS, USDA for 1967:

"During September 1966 this aphid was recovered at Moorestown, Medford, Bridgeton and Greenwich. During a warm spell on Jan 24, 1967 when the temperature was in the 60's a few spotted alfalfa aphids were collected at Dover, Del. and on Jan 25 at Greenwich, N.J. These recoveries indicate that the aphid remains active in the field when weather conditions are favorable during the winter months." (Report for first quarter).

"A search was made for spotted alfalfa aphid beginning in March at weekly intervals at 3 locations in Delaware and 6 in New Jersey. The aphid was not recovered until June. These results indicate that it does not overwinter in either of these states and that it migrates northward during late spring." (Report for second quarter).

Following are the dates and localities where the spotted alfalfa aphid was first recovered during the quarter: 19 July Greenwich, 3 aphids per 100 sweeps; 27 July Moorestown, 27 aphids per 100 sweeps; 2 Aug Medford, 2 aphids per 100 sweeps; 2 Aug Rancocas, 2 aphids per 100 sweeps. By the end of the quarter the population at Moorestown had increased to 173 aphids per 100 sweeps. (Report for third quarter).

Populations of the spotted alfalfa aphid at Moorestown per 100 sweeps during the last quarter:

Date—	10/5,	10/12,	10/23,	10/30,	11/7,	11/14,	11/27,	12/5,	12/13,	12/29.
Pop.—	252,	398,	983,	236,	72,	31,	25,	5,	4,	0.

Mr. George Angelet, Insect Identification and Parasite Introduction Research Branch, Entomol. Res. Div., ARS, USDA at Moorestown, N.J. wrote me 6 Jan 1969 as follows:

"I did not do much with the spotted alfalfa aphid during 1968 but did check several areas in New Jersey for the presence of the insect. Following are the localities where I have found the aphid as well as the areas where it was not present:

Present Greenwich, Fairton, Rhoadstown, Shiloh, Moorestown, Cream Ridge, Pole Tavern, Elmer, Rancocas, Medford, Jacksonville.

None found—Hightstown, Cranbury, Marlboro, Vail, Hope, Quakerstown.

NOTE BY AUTHOR: It should be noted that the data in the above quarterly reports are the result of Mr. Angelet's activities. It should also be noted that Mr. Angelet has in press with the J. Econ. Entomol. a paper entitled, "Notes on the spotted alfalfa aphid and the pea aphid in New Jersey, Delaware, and the Eastern Shore of Maryland," in which some of the foregoing data is presented in a somewhat different manner. In it he also has observations on the parasites and predators of these two aphids. My thanks are due him for permission to use his data.

In regard to the spotted alfalfa aphid the following paragraph in his paper is significant:

H. M. Graham, "Effects of temperature and humidity on the biology of *Therioaphis maculata* (Buckton)," *in* Univ. Calif. Publ. Entomol., **16**(2): 47–80, 1959 reported that a low humidity, 25 to 30% and 30°C are optimum for rapid reproduction of the spotted alfalfa aphid and that high humidity is detrimental to its reproduction. The regions of the world in which *T. maculata* has been reported to be a serious pest of alfalfa are semiarid with relatively high temperatures during the periods when the aphid is active. The average annual rainfall from April to September in the areas where my studies were made range from about 20 to 25 inches and relative humidity about 75% at 8:00 a.m. and 65% at noon during July. These environmental conditions in the study areas in addition to the low temperatures during the winter months are likely to be highly unfavorable to the rapid reproduction of this species.

Tuberolachnus salignus (Gmelin), Giant Bark Aphid. (Often placed in *Lachnus*). Wayne, Pasaic Co. 19 Sept 1967 a very heavy infestation on bark of willow (Conlon coll). "Common on willow trees throughout the State." (CEIR, **17**(41):927, 13 Oct 1967). "Heavy throughout New Jersey during the late summer and early fall. (Summary of Insect Conditions 1967 *in* CEIR, **18**(13): 249, 29 Mar 1968).

LIST OF FOOD PLANTS*

* Plants marked with one asterisk (*) are additional species and with two asterisks (**) are additional genera to those in the previous lists.

- _Acer negundo_ (Boxelder)
  - _Periphyllus negundinis_
- *_Acer palmatum dissectum_ (Japanese Red Maple)
  - _Periphyllus californicum_
- _Acer platanoides_ (Norway Maple)
  - _Periphyllus lyropictus_
- Alfalfa—see _Medicago sativa_
- **_Althaea rosea_
  - _Aphis gossypii_
- **_Anthurium schezeriana_
  - _Acyrthosiphum solani_
- _Apocynum androsaemifolium_ (Spreading Dogbane)
  - _Macrosiphum euphorbiae_
- _Apocynum canabinum_ (Indian Hemp)
  - _Aphis asclepiadis_
  - _Macrosiphum euphorbiae_
- Apple—see _Malus pumila_
- _Aquilegia_ sp. (Columbine)
  - _Kakimia essigi_
  - _Macrosiphum euphorbiae_
  - _Pergandeidia trirhoda_
- Arrowhead, Common—see _Saggitaria latifolia_
- _Artemisia vulgaris_ (Mugwort)
  - _Pleotricophorus glandulosus_
- _Asclepias syriaca_ (Common Milkweed)
  - _Aphis asclepiadis_
- _Asparagus officinalis_
  - _Macrosiphum euphorbiae_
- _Aster_ sp.
  - _Dactynotus paucosensoriatus_
  - _Macrosiphum euphorbiae_
- _Azalea_, Swamp—see _Rhododendron viscosum_
- Barley—see _Hordeum vulgare_
- Basswood—see _Tilia_
- Beech—see _Fagus_
- _Betula populifolia_ (Gray or Yellow Birch)
  - _Euceraphis deducta_
  - _Euceraphis linenta_
  - _Calaphis_ n. sp.
  - _Calaphis betulaecolens_
- Birch, Gray—see _Betula populifolia_
- Birch, Yellow—see _Betula populifolia_
- Bittersweet—see _Celastrus_
- Blackeye Susan—see _Rudbeckia hirta_
- Black Locust—see _Robinia pseudacacia_
- Bleedingheart—see _Dicentra_
- Blueberry—see _Vaccinium_
- Boxelder—see _Acer negundo_
- Boxwood—see _Buxus_
- **_Buxus_ sp. (Boxwood)
  - _Macrosiphum rosae_
- _Capsicum frutescens_ (Redpepper)
  - _Macrosiphum euphorbiae_
  - _Myzus persicae_
- **_Caragana arborescens pendula_
  - ? _Aphis craccivora_
- Carnation—see _Dianthus_
- _Carya_ sp. (Hickory)
  - _Melanocallis caryaefoliae_
- _Celastrus scandens_ (Bittersweet)
  - _Aphis craccivora_
- _Cephalanthus occidentalis_ (American Bittersweet)
  - _Aphis cephalanthi_
- _Chaenomeles japonica_ (Flowering Crab)
  - _Aphis pomi_
  - _Macrosiphum euphorbiae_
- *_Chaenomeles speciosa_
  - _Aphis pomi_
- Cherry—see _Prunus_
- Chickweed—see _Stellaria media_
- Chinese Scholar Tree—see _Sophora japonica_
- _Chrysanthemum_ sp. (cult)
  - _Coloradoa rufomaculata_
  - _Macrosiphoniella sanborni_
- _Cichorium endivia_ (Endive or Escarole)
  - _Myzus persicae_
  - _Pemphigus_ sp.
- _Cirsium_ sp. (Thistle)
  - _Brachycaudus cardui_
- **_Cladrastis lutea_ (Yellow-wood)
  - _Aphis craccivora_
- Columbine—see _Aquilegia_
- **_Columnea_ sp. vars. "Oriole" and "Yellow Dragon"
  - _Acyrthosiphon solani_

Columnea hybrid "Betty Stoehr"
  Acyrthosiphon solani
**Columnea* hybrid "Orange Fire"
  Acyrthosiphon solani
**Columnea percrassa*
  Acyrthosiphon solani
Corn Sweet—See *Zea mays* var. *saccharata*
***Corytholoma* sp.
  Acyrthosiphon solani
Cotoneaster sp.
  Aphis pomi
Crabapple—see *Malus*
Crataegus crusgalli (Cockspur Hawthorn)
  Amphorophora crataegi
  Eriosoma crataegi
Cucurbita pepo (Pumpkin)
  Macrosiphum euphoribiae
***Cyphomandra betaceae* (Tomato Tree)
  Myzus persicae
Dactylis glomehata (Orchardgrass)
  Schizaphis graminum
Daisy Fleabane—see *Erigeron annuus*
***Datura* sp.
  Macrosiphum euphorbiae
  Myzus persicae
Dianthus caryophyllus (Carnation)
  Myzus persicae
***Dicentra* sp. (Bleedingheart)
  Macrosiphum euphorbiae
Dock, Broad-leaved—see *Rumex obtusifolia*
Dogbane, Spreading—see *Apocynum androsaemifolium*
Eggplant—see *Solanum melogena*
English Ivy—see *Hedera helix*
Endive or Escarole—see *Cichorium endivia*
***Epidendrum aurantiacum* an orchid (synonym of *Leliocattleya luminosa*)
  Acyrthosiphon solani
**Erigeron annuus* (Daisy Fleabane)
  Dactynotus erigeronensis
  Dactynotus gravicornis
  Dactynotus tissoti
Erigeron sp. (Fleabane)
  Dactynotus ambrosiae complex
**Erigeron canadensis* (Horseweed Fleabane)
  Dactynotus erigeronensis
  Dactynotus gravicornis
Escarole or Endive—see *Cichorium endivia*
Euonymus sp. (Spindle Tree)
  Aphis fabae
Evening Primrose—see Oenothera
Fagus sp. Beech
  Phyllaphis fagi
  Prociphilus imbricator
Fagus sylvatica var. *purpurea* (Copper or Purple Beech)
  Phyllaphis fagi
Firethorn—see *Pyracantha*
Fleabane—see *Erigeron*
Flowering Crab—see *Chaenomeles japonica*
Forsythia sp.
  ?*Aphis gossypii*
***Gaylussacia frondosa* (Blue Huckleberry)
  ?*Masonaphis* sp.
***Gesneria cuneifolia*
  Acyrthosiphon solani
Gloriosa Daisy—see *Rudbeckia hybrid*
Gloxinia—see *Sinningia*
Goldenrod—see *Solidago*
Gromwell—see *Lithospermum* sp.
Hawthorn—see *Crataegus*
Hedera helix (English Ivy)
  Aphis hederae
Helianthus annuus (Common Sunflower)
  Aphis helianthi
***Hesperis matronalis* (Sweet Rocket)
  Aphis gossypii
**Hibiscus rosa-sinnensis* (Rose-of-China)
  Myzus persicae
Hickory—see *Carya*
**Hieracium gronovii*
  Nasonovia ribisnigri
**Hieracium pratense* (King Devil)
  Nasonovia ribisnigri
Holly—see *Ilex*
Honeysuckle—see *Lonicera*
Hordeum vulgare (Barley)
  Schizaphis graminum
Hydrangea sp.
  Acyrthosiphon solani
  Macrosiphum euphorbiae
***Hypocerta wettsteinii*
  Acyrthosiphon solani
**Ilex* sp. Burford Holly
  Macrosiphum rosae
Indian Hemp—see *Apocynum cannabinum*
Iris sp.
  Macrosiphum euphorbiae
Ipomoea batatas (Sweet Potato)
  Myzus persicae
Juglans nigra (Black walnut)

Chromaphis juglandicola
Monelliopsis caryae
Juglans regia (English or Persian Walnut)
Chromaphis juglandicola
***Juniperus scopulorum* (Blue Haven)
Cinara cupressi (Rocky Mt. Juniper)
Kidney Bean—see *Phaseolus vulgaris*
King Devil—see *Hieracium pratense*
***Leliocattleya luminosa*—see also *Epidendron aurantiacum*
Acyrthosiphon solani
Lettuce—see *Lactuca*
Lactuca sp. (Lettuce)
Dactynotus sonchellus
**Lactuca alba*
Macrosiphum euphorbiae
Lactuca sativa (Garden Lettuce)
Myzus persicae
***Leliocattleya truffautiana* an orchid (see also *Epidendron aurantiaca*)
Acyrthosiphon solani
Liriodendron tulipifera (Tuliptree)
Macrosiphum liriodendri
***Lithospermum* sp. (Gromwell)
Macrosiphum euphorbiae
Lonicera sp. (Honeysuckle)
Hydaphis foeniculi
Lotus—see *Nelumbium*
Lycopersicon esculentum (Tomato)
Macrosiphum euphorbiae
Myzus persicae
Lyonia (*Pieris*) *mariana* (Scatterbush)
Aphis spiraecola
Magnolia virginianum (Sweetbay)
Macrosiphum liriodendri
Malus sp. Crabapple
Aphis pomi
**Malus atrosanguinea* (Carmine Crabapple)
Aphis pomi
**Malus hopa*
Aphis pomi
Malus pumila (Apple)
Aphis pomi
**Malus purpurea eleyi* (Crimson Crabapple)
Aphis pomi
Maple, Japanese—see *Acer palmatum dissection*
Maple, Norway—see *Acer platanoides*
Medicago sativa—see Alfalfa
Acyrthosiphon pisum
Therioaphis maculata
Mentha spicata (Spearmint)
Ovatus crataegarius
Milkweed—see *Asclepias*
Mockorange—see *Philadelphus*
Mountain Ash—see *Sorbus*
Mugwort—see *Artemisia vulgaris*
Nelumbium (*Nelumbo*) *lutea* (American Lotus)
Rhopalosiphum nymphaeae
Nymphaea sp. (Waterlily)
Rhopalosiphum nymphaeae
Nyssa sylvatica (Tupelo)
Aphis coreopsidis
Oak—see *Quercus*
Oenothera sp. (Evening Primrose)
Macrosiphum gaurae
Orchardgrass—see *Dactylis glomerata*
Orchid—see *Epidendron*
Orchid—see *Leliocattleya*
Painted Daisy—see *Chrysanthemum*
Peach—see *Prunus persica*
Phaseolus vulgaris (Kidney Bean)
Aphis fabae
Philadelphus sp. (Mockorange)
Aphis fabae
Philadelphus inodorus
Aphis fabae
Macrosiphum euphorbiae
Picea sp. (Spruce)
Picea sp. (Spruce)
Cinara braggii
?*Cinara pilicornis*
Cinara pinicola
**Picea* (*excelsa*) *abies* (Norway Spruce)
Cinara pilicornis
**Picea pungens* (Colorado Blue Spruce)
Cinara sp.
Pinus sp. Pine
Cinara pinea
Pinus rigida (Pitch Pine)
Cinara carolina
Cinara pinivora
Cinara watsoni
Pinus strobus (White Pine)
Cinara strobi
Pinus sylvestris (Scotch Pine)
Cinara pinea
Plum—see *Prunus*
Poison Ivy—see *Rhus toxicodendron*
Polygonum sp. (Smartweed)
Aphis fabae

- Potato—see _Solanum tuberosum_
- _Prunus_ sp. (Cherry)
  - _Myzus cerasi_
- _Prunus_ sp. a red horticultural plum
  - _Aphis spiraecola_
- *_Prunus blireiana_ (Blireiana Plum)
  - _Hyalopterus pruni_
- _Prunus persicae_ (Peach)
  - _Brachycaudus persicicola_
  - _Myzus persicae_
- _Pyracantha_ sp. (Firethorn)
  - _Aphis spiraecola_
- *_Pyrethrum_ sp. or _Chrysanthemum coccineum_? (Painted Daisy)
  - ?_Macrosiphoniella tanacetaria_
- _Quercus_ sp. (Oak)
  - _Longistigma caryae_
  - _Myzocallis multisetis_
  - _Myzocallis walshii_
  - _Stegophylla quercina_
- *_Rechsteineria verticillata_
  - _Acyrthosiphon solani_
- Redpepper—see _Capsicum frutescens_
- _Rheum rhaponticum_ (Rhubarb)
  - _Aphis fabae_
- **_Rhododendron viscosum_ (Swamp Azalea)
  - _Masonaphis rhokalaza_
- Rhubarb—see _Rheum rhaponticum_
- _Rhus toxicodendron_ (Poison Ivy)
  - _Glabromyzus howardii_
- _Robinia pseudacacia_ (Black Locust)
  - _Aphis craccivora_
- _Rosa_ sp. (Rose, cultivated)
  - _Acyrthosiphon porosum_
  - _Macrosiphum euphorbiae_
- _Rosa palustris_ (Swamp Rose)
  - _Macrosiphum euphorbiae_
- Rose-of-China—_Hibiscus rosa-sinensis_
- _Rudbeckia hybrid_ (Gloriosa Daisy)
  - _Dactynotus_ sp.
- _Rudbeckia hirta_ (Blackeye Susan)
  - _Dactynotus leonardi_
- _Rumex obtusifolia_ (Broad-leaved Dock)
  - _Aphis rumicis_
- _Saggitaria latifolia_ (Common Arrowhead)
  - _Rhopalosiphum nymphaeae_
- _Salix_ sp. (Willow)
  - _Chaitophorus_ sp.
  - _Tuberolachnus salignus_
- _Salix discolor_ (Pussy Willow)
  - _Macrosiphum californicum_
- Smartweed—see _Polygonum_
- Snowball Tree—_Viburnum opulus_
- *_Solanum canadense_
  - _Macrosiphum euphorbiae_
- _Solanum melogena_ (Eggplant)
  - _Macrosiphum euphorbiae_
  - _Myzus persicae_
- _Solanum tuberosum_ (Potato)
  - _Acyrthosiphon solani_
  - _Macrosiphum euphorbiae_
  - _Mysus persicae_
- _Solidago_ sp. (Goldenrod)
  - _Dactynotus nigrotuberculatus_
- _Sophora japonica_ (Chinese Scholar Tree)
  - _Aphis craccivora_
- _Sorbus americana_ (American Mountainash)
  - _Aphis pomi_
- Spearmint—see _Mentha spicata_
- Spindletree—see _Euonymus_
- _Spiraea bumalda_ (Anthony Waterer)
  - _Aphis spiraecola_
- _Spiraea prunifolia_ (Bridalwreath Spiraea)
  - _Aphis spiraecola_
- *_Spiraea thunbergii_
  - _Aphis spiraecola_
- _Spiraea vanhouttei_
  - _Aphis spiraecola_
- Spruce—see _Picea_
- Squash—see _Cucurbita pepo_
- _Stellaria media_ (Common Chickweed)
  - ? _Myzus certus_
- **_Streptocarpus rexii_
  - _Acyrthosiphon solani_
- Sunflower—see _Helianthus_
- Sweetbay—see _Magnolia virginiana_
- Sweet potato—see _Ipomoea batatas_
- Sweet Rocket—see _Hesperis_
- Thistle—see _Cirsium_
- **_Thuja_ sp. (Arborvitae)
  - _Cinara tujafilina_
- _Tilia_ sp. (Basswood)
  - _Longistigma caryae_
- _Tilia cordata_ (Littleleaf Linden)
  - _Eucallipterus tiliae_
- Tomato—see _Lycopersicon_
- Tree Tomato—see _Cyphomandra_
- Tuliptree—_Liriodendron_
- Tupelo—see _Nyssa sylvatica_
- _Vaccinium corymbosum_ (Cultivated Highbush Blueberry)

? *Aphis gossypii*
Fimbriaphis sp.
Masonaphis pepperi
Viburnum opulus (European Cranberry Bush or Snowball Tree)
Neoceruraphis viburnicola
Walnut—see *Juglans*
Waterlily—see *Nymphaea*
Willow—see *Salix*
Yellow-wood—see *Cladrastis lutea*
Zea mays var. *saccharata* (Sweetcorn)
Rhopalosiphum maidis

Notes on the Life History of *Zestusa dora* (W. H. Edwards) (Lepidoptera: Hesperiidae)

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Abstract: *Zestusa dora* (W. H. Edwards) (Hesperiidae) is closely associated with oak-juniper scrub in the southern Arizona mountains, where it was studied in April and May in Cochise Co., Arizona. Eggs and young larvae were found in April, 1969, on *Quercus Emoryi* Torrey and reared through on this and other species of *Quercus*. The beginning of the life cycle coincides with the beginning of the spring growth of the *Quercus* and also with wider availability of water. The adults drink water whenever possible but seldom visit flowers. Descriptions are given of the chief characteristics of the eggs, larvae and pupae. Structures on the dorsocaudal edge of the prothorax and around the prothoracic spiracle of the pupa are probably of generic importance.

During April and May of 1969 the writer, while at the Southwestern Research Station of The American Museum of Natural History, near Portal, Cochise Co., Arizona, made observations of the life history, habits and ecology of *Zestusa dora* (W. H. Edwards). This common skipper of the Southwest and northern Mexico does not appear to have been hitherto reared. Adults were observed between 15 April and 10 May every time the right environment was visited and the weather was favorable. The localities where the species was seen were: Campground, South Fork, Cave Creek Canyon, alt. about 5300 ft.; S. W. Research Station, Cave Creek Canyon, alt. 5400 ft.; Ash Spring; Herb Martyr Dam Campground; and several locations along the road from Cave Creek Canyon to Onion Saddle, altitudes 6400 ft. to 7000 ft.

ECOLOGY AND ADULT BEHAVIOR

The species was always found associated with the open oak-juniper scrub that occupies large areas in the lower parts of the Chiricahua and similar Arizona mountain ranges. Adults were always associated with *Quercus arizonica* Sarg. and *Q. Emoryi* Torrey, the two dominant oaks of the region. The appearance of the adults from hibernating pupae is closely in phase with the beginning of seasonal growth of the oaks, i.e., shedding the leaves that have persisted from the previous year, the opening of the buds and the appearance of flowers and new leaves. The eggs thus hatch in time for the larvae to do most or all of their feeding on the new leaves. Adults were commonly seen flying among and over the foliage, sometimes in considerable numbers. On 18 April about 15 were seen actively flying in and out of, and alighting in, a *Q. Emoryi* by the roadside

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about ½ mile above Turkey Creek. None of these was seen to oviposit; but a little later two females were seen to oviposit on an adjacent *Q. Emoryi*, although the eggs were not found. On other occasions the same thing was noted: the tendency of the adults to concentrate on one particular tree. The trees that the adults flew about, and those on which eggs and larvae were found, were all *Q. Emoryi*; but there is no reason to rule out *Q. arizonica* as a food plant.

Wherever water was available the adults spent much time drinking from mud or wet rocks. This was observed near the Research Station, and at Herb Martyr Dam, Ash Spring and Turkey Creek. One adult was watched crawling on the moist surface of a small stem gall on a *Q. Emoryi* with its proboscis extended. Another was seen to insert its proboscis in a small drop of spittlebug (Cercopidae) secretion on a *Q. Emoryi* leaf. There were many such drops of secretion available. Only one adult was seen visiting a flower, which was of *Ceanothus integerrimus* Hook. & Arn., although there were many clumps of this shrub, and of *Berberis wilcoxi* Kearney, blooming in the environments. The flowers of these shrubs were being eagerly visited by adults of *Leptotes marina* (Reakirt), *Erora quaderna* (Hewitson), *Callophrys* (*Mitoura*) *spinetorum* (Hewitson) and *siva* (W. H. Edwards), and *Erynnis juvenalis clitus* (W. H. Edwards).

EARLY STAGES

Eggs and larvae were found as follows, all on the particular *Q. Emoryi* tree about which so many individuals were seen flying on 18 April. One second instar larva was found on 25 April, in a small flap nest in a young leaf. An eggshell and a recently emerged larva were found on a bud scale on 1 May. On 10 May, Killian Roever and I found 2 eggshells, 1 unhatched egg and 6 second instar larvae, all on leaves. The larvae were all in small flap nests, made by cutting out two sides of a small rectangle at the edge of a leaf and folding and fastening this beneath the leaf. Of this material I was able to carry back to New York and rear through the pupal stage 3 individuals, despite the fact that the food plant had to be changed twice, first to *Quercus gambeli* and then to *Q. alba*. Pupae were formed about 1 June and on 15 June and 18 June. The adults never succeeded in emerging from the pupae, perhaps because of failure to break a diapause. However, they became fully formed, so that when all hope of their emergence was abandoned the pupal shells were opened and positive identification was made.

EGG. The freshly laid egg was yellowish green; it became yellower as it matured. It is a truncate cone with a maximum diameter of about 1.2 mm., slightly smaller in diameter basally and considerably smaller in diameter distally. (The exact length and the distal structures were undeterminable because of eating by the emerging larvae.) One egg had 14, the other 15, strongly protruding longitudinal ridges, the spaces between which were crossed at right angles by about 50 very small, transverse ridges.

LARVA. In all instars the larva makes and lives in flat flap nests made by partly cutting a piece at the edge of a leaf and bending this down beneath and securing it with silk. Fully mature larvae may tie together more than one leaf. The head capsules averaged in width as follows: 1st instar (1 larva) .716 mm.; 2d instar (4 larvae) 1.27 mm.; 3d instar (3 larvae) 2.05 mm.; 4th instar (3 larvae) 3.18 mm.; 5th instar (3 larvae) 4.49 mm. In the first four instars the larvae are pale greenish yellow with indistinct cross lines on the segments; the head is blackish with fine, sunken, irregular reticulations and coarse, raised blunt granulations which are most prominent dorsolaterally. The head is shallowly emarginate middorsally, and bears sparse, short, fine setae.

MATURE LARVA (5TH INSTAR). Length when contracted and resting 31–39 mm. Head shallowly emarginate middorsally, with coarse, irregular reticulations between coarse, blunt granulations, the latter largest and most protruding dorsolaterally. Colors darkest in grooves of reticulations, lightest on prominences of granulations. Color bright orange yellow dorsally and laterally, darkening to darker, but bright, orange brown on subventral areas of face. Central, triangular sclerite of face (the frons of most taxonomists, really the true clypeus, Klots, 1966, J. N. Y. Entomol. Soc., **74:** 185, footnote) contrastingly light brownish yellow; ventrolateral areas of face similar light brownish yellow on each side below a line from slightly dorsad of most dorsal ocellus over to facial triangle. Ocelli pale, in a narrow, curved, very dark band. Clypeus and mandibles dark brown, labrum pale and colorless. Head clothed with sparse, very short, fine setae.

Prothoracic collar shining, bright orange brown dorsally, paler at lateral ends. Body pale, slightly greenish yellow, darker and more greenish ventrolaterally. A broad, pale, irregular middorsal line, beginning on metathorax and extending caudad to taper out on 8th abdominal segment; middorsally along this a very narrow, darker, greenish line above aorta. A prominent light yellowish, dorsolateral line on each side, beginning on mesothorax and extending caudad to caudal margin of 8th abdominal segment; here a light, transverse line runs across caudal edge of segment, connecting the ends of the dorsolateral lines. Posterior and lateral margins of last abdominal segment (telson) rounded and broadly light yellowish. Narrow, irregular, transverse yellowish lines across most of the segments dorsally and dorsolaterally, especially posteriorly. Each segment more or less covered with small, light yellowish, rounded spots, these tending dorsolaterally to be slightly larger and arranged in single or double, transverse rows. A slightly protruding ventrolateral ridge above bases of legs and prolegs, especially caudally. Prolegs and ventral surface pale green. The larva resting inside its nest usually hooks its body horizontally so that the head is facing caudad and against the side of the abdomen, commonly at the 6th abdominal segment.

Pupa. Total length of 3 individuals: 18.4, 17.8 and 19.0 mm. Percentages of total length, measurements taken between middorsal limits: head 6, thorax 36, abdomen 58. Dorsoventral diameter of thorax taken at posterior edge of metathorax, 32.2% of total length. Dark reddish brown, surface rough and irregularly reticulate and granulate, where clean and protruding quite shiny. Considerably covered at pupation by a liquid secretion that dries to form a chalky crust. (This, occurring in many Pyrginae, may have an important protective function, perhaps against desiccation.) Mandibular sclerites with no particularly large tubercles or bristles. Each compound eye with a small cluster of dark pigmented, large, protruding, more or less transparent rugosities. Prothoracic spiracle rimmed posteriorly by a very strongly protruding, heavily sclerotized, irregularly ridged, flat, semicircular ring; inside the cephalad concavity of this, leading to the spiracle, a lining of very short, dense hairs. No special hairs or setae on posterior edge of prothorax at cephalic edge of spiracle. On either side of middorsal line along caudal edge of pronotum a series of 4–6 very strong, heavily sclerotized, blunt teeth extending caudad. Last pair of abdominal spiracles particularly small and non-functional. Cremaster arising basally from a very heavily sclerotized, protruding, transverse ridge with many short blunt teeth along its cephalic margin; this runs ventrad to about the middle of each side. Cremaster very heavily sclerotized, its surface very heavily and irregularly rugose, tapering abruptly to a blunt tip bearing a thick cluster of strong hooklets. A deep, triangular depression, its apex caudad, in dorsal surface of cremaster. On either side and caudad of the slitlike genital opening a strong, irregular, longitudinal ridge, which ends caudally in a bicurved, transverse ridge with much enlarged lateral ends. Caudad of this is the slit representing the anal orifice, ventrad of the base of the cremaster.

It is, perhaps, not very fruitful, and is certainly a bit frustrating, thus to describe larval and pupal characters when so little comparative work has been done on these stages. Often we do not know what characters may or may not be valuable, and on what taxonomic level. The blunt teeth on the posterior margin of the pupal prothorax are an example; they appear to be constant in *X. dora*. In 2 pupae of *Epargyreus clarus* and one of *Erynnis icelus* that happen to be at hand there is one such tooth on each side in the *E. clarus*, none in the *E. icelus*. This character, which appears to have escaped general notice, may be very useful in generic or even tribal taxonomy. The structures surrounding the prothoracic spiracle are certainly very important, differing greatly in such other pyrgine genera as *Achalarus*, *Autochton*, *Epargyreus* and *Erynnis*, as Scudder showed long ago. Obviously we need a great deal more life history work, the specimens resulting from which should be deposited in permanent collections where they will some day be available for comparative work.

All specimens have been deposited in The American Museum of Natural History. I am greatly obliged to Vincent Roth of the Southwestern Research Station for advice about collecting localities and plant identifications, and to Killian Roever for especially appreciated aid in collecting eggs and larvae.

Peripsocus Species of the Alboguttatus Group (Psocoptera: Peripsocidae)

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Abstract: The *alboguttatus* group of the genus *Peripsocus* is defined on the basis of genitalic features of both sexes and forewing-marking pattern. Ten species are included, seven of which are described as new and are named as follows: *P.* **alachuae**, *P.* **australis**, *P.* **maculosus**, *P.* **minimus**, *P.* **monticola**, *P.* **potosi**, *P.* ***teutonicus***. The forewing-marking pattern common, with minor modifications, to most species of the group is departed from by *P.* **monticola** n.sp., but this species is obviously very close to another included member, *P.* **australis** n.sp., as shown by genitalic features of both sexes. The taxonomic treatment is based on examination of 543 adult specimens. The location of the major types of each new species is mentioned in its description. A neotype of *P. madescens* Walsh is designated. A brief discussion of probable phylogenetic relationships within the species group is included. The *alboguttatus* group is represented in eastern United States by five species, one of which enters southeastern Canada. *P. alboguttatus* Dalman occurs throughout Europe as well as in North America. In Mexico there are two species in the group, one of which ranges south into northern South America and occurs on Trinidad, Puerto Rico, and Jamaica in the West Indies. Another species is known from Jamaica. Two species are known from southern Brazil, and one occurs in West Africa.

The genus *Peripsocus* is a cosmopolitan genus in which 80 species are now known including those here described as new. Thornton and Wong (1967) presented ideas on possible relationships of 15 species of the Pacific Basin, but to date no classification of the world fauna of this genus has been made. The species group set out in the present paper may have to be modified when such a classification is made.

The *alboguttatus* group may be characterized as follows:

1. Male clunium (fused abdominal terga 8–10) adorned with a single process projecting from its posterior margin on the dorsal mid-line.
2. Male radular sclerotizations in the form of a fork sclerite (Pearman, 1951).
3. Male with costal vein thickened for almost its entire length from wing base to base of pterostigma.
4. Male phallosome of approximately equal width throughout most of its length, not decidedly narrower in its anterior half.
5. Female subgenital plate with its apical process rounded posteriorly, showing no trace of indentation.

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6. The complex forewing markings adhere closely to a pattern summarized in the following outline (see Fig. 1):

- I. Transverse rows of spots: rows oriented transversely (on diagonals) to long axis of wing.
  - A. Dark transverse rows
    - 1. First dark transverse row (Fig. 1, d.t.r. no. 1): spot no. 1 in middle of cell R; spot no. 2 in basal third of cell Cu$_1$; spot no. 3 in middle of cell Cu$_2$.
    - 2. Second dark transverse row (Fig. 1, d.t.r. no. 2): spot no. 1 in cell R$_1$ near base of cell; spot. no. 2 in distal end of cell R; spot no. 3 in cell M$_3$ near base of cell; spot no. 4 in middle of cell Cu$_1$; spot no. 5 in cell Cu$_2$ distad of middle.
    - 3. Third dark transverse row (Fig. 1, d.t.r. no. 3): spot no. 1 in middle of cell M$_3$; spot no. 2 in distal end of cell Cu$_1$.
  - B. Pale transverse rows
    - 1. First pale transverse row (Fig. 1, p.t.r. no. 1): spot no. 1 in base of cell R$_1$; spot no. 2 near distal end of cell R between the two dark spots; spot no. 3 in basal end of cell M$_3$; spot no. 4 just basad of middle of cell Cu$_1$ between the two dark spots; spot no. 5 toward distal end of cell Cu$_2$ between the two dark spots.
    - 2. Second pale transverse row (Fig. 1, p.t.r. no. 2): spot no. 1 in cell R$_1$ near base, distad of dark spot no. 1 of second transverse row; spot no. 2 in cell M$_3$ between the dark spots of second and third transverse rows; spot no. 3 in cell Cu$_1$ immediately above nodus.
- II. Radial series of spots: spots arranged in arcs in distal third of wing, the arcs approximately centered on a prominent dark spot in base of cell R$_5$. These are absent in *P.* **monticola** n.sp.
  - A. Pale radial series
    - 1. Inner pale radial arc (Fig. 1, i.p.r.a.): spot no. 1 in cell R$_1$ below distal end of pterostigma; spot no. 2 in cell R$_3$ near base of cell; spot no. 3 in cell R$_5$ distad of middle of cell; spot no. 4 in cell M$_1$ near base of cell; spot no. 5 in cell M$_2$ near base of cell; spot no. 6 in cell M$_3$ near branching of vein M$_3$ from median stem.
    - 2. Outer pale radial arc (Fig. 1, o.p.r.a.): each spot distad of the spot of inner arc, but no spot exists corresponding to spot no. 6 of inner arc.
  - B. Dark radial series
    - 1. Inner dark radial arc (Fig. 1, i.d.r.a.): five spots between the spots of the two pale arcs. A large dark spot distad of spot no. 6 of the inner pale radial arc is spot no. 6 of this arc.
    - 2. Outer dark radial arc (Fig. 1, o.d.r.a.): series of five spots each distad to a spot of the outer pale radial arc. Spots of the inner and outer dark radial arcs may surround spots of the outer pale radial arc and thus coalesc.

Diagnosed as above, the *alboguttatus* group includes the following nine species:

→

FIGS. 1–9. Forewings of *Peripsocus alboguttatus* group species, all drawn at scale shown (scale in mm.). Fig. 1. *P.* **maculosus** n.sp. ♀, large specimen from Quebec. Abbreviations explained in text. Fig. 2. *P.* **maculosus** n.sp. ♀, small specimen from Virginia. Fig. 3. *P.* **alachuae** n.sp. ♀. Fig. 4. *P.* **minimus** n.sp. ♀. Fig. 5. *P.* **potosi** n.sp. ♀. Fig. 6. *P.* **teutonicus** n.sp. ♀. Fig. 7. *P. alboguttatus* Dalman ♀ from Maryland. Fig. 8. *P. alboguttatus* Dalman ♀ from British Columbia. Fig. 9. *P. madescens* Walsh ♀.

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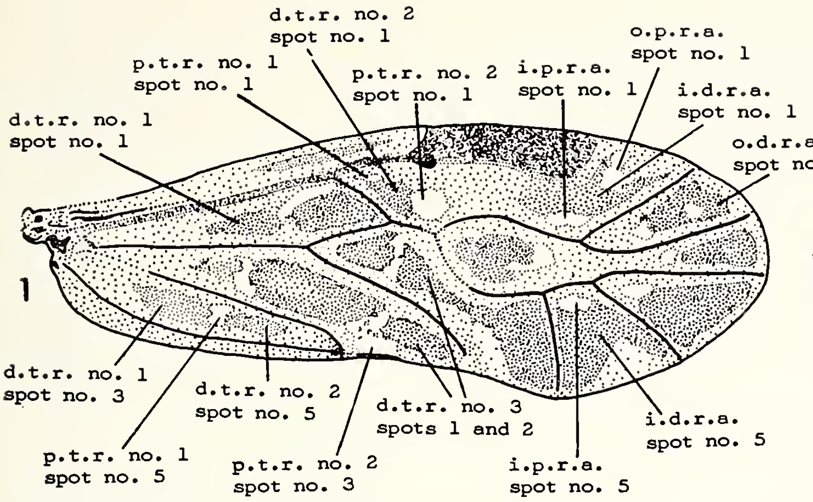
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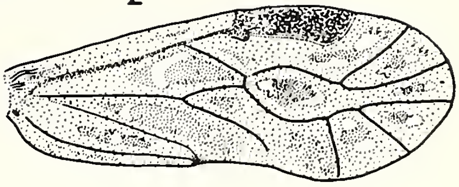

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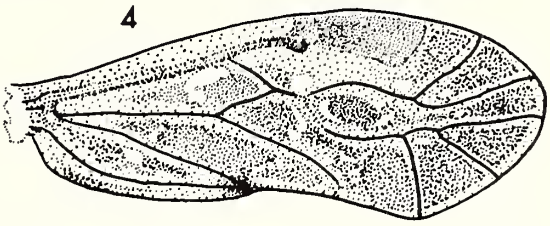

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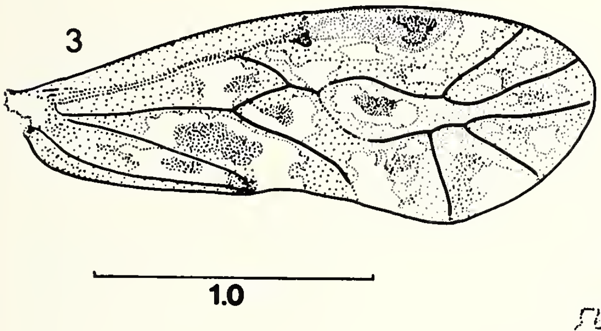
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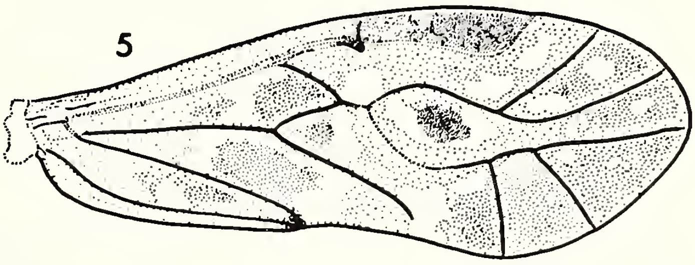

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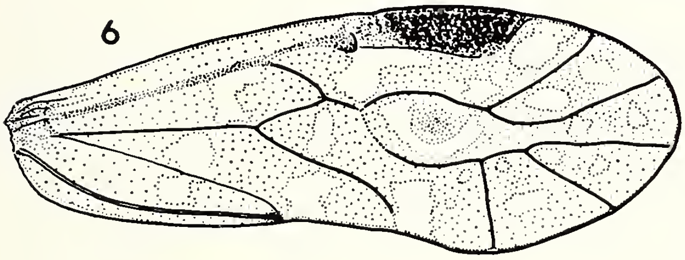

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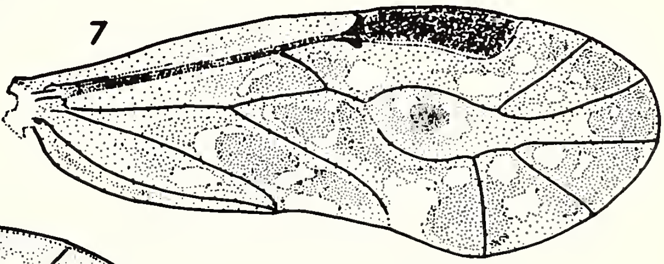

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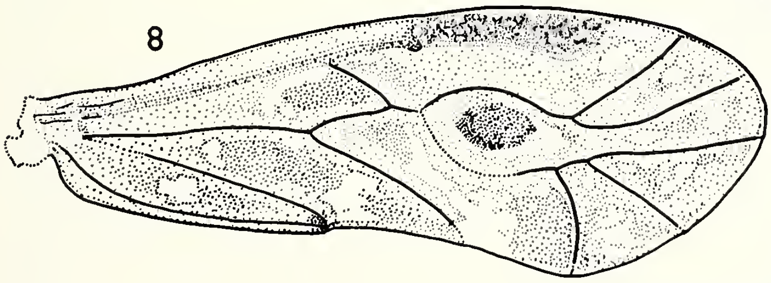

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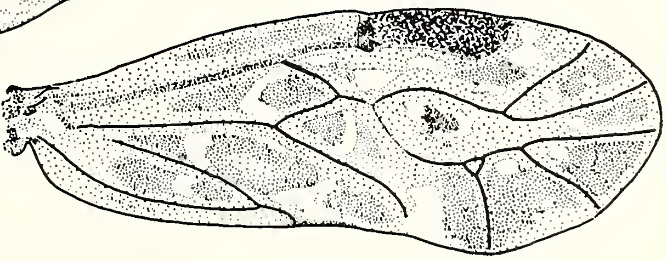


P. **alachuae** n.sp., *P. alboguttatus* Dalman, *P.* **australis** n.sp., *P. balli* Badonnel (but probably not the male tentatively assigned to that species by Badonnel in 1969. See discussion under that species), *P.* **maculosus** n.sp., *P. madescens* Walsh, *P.* **minimus** n.sp., *P.* **monticola** n.sp. (although forewing markings depart considerably from those described above), *P.* **potosi** n.sp., and *P.* **teutonicus** n.sp.

Measurements (Table 1) were taken on whole specimens mounted temporarily in glycerine on a well slide. A filar micrometer was used, giving a micrometer unit of 2.63 μ for forewing and posterior tibial lengths, and of 1 μ for all other measurements.

Epiproctal and paraproctal characters do not differ interspecifically enough to warrant their description for each species. The number of trichobothria in the sensory cushion of the female paraproct varies from 16 to 25. Most of the species occupy either the middle or almost all of this range, but *P.* **maculosus**, with 19 to 22 for six individuals counted, is toward the low end, and *P.* **potosi**, with 16 to 19 for three individuals counted, is further toward that end. Three shapes of female epiproct are seen. One decidedly tapering from a broad base (Fig. 45) occurs in *P.* **alachuae**, *P. alboguttatus, P.* **maculosus**, *P. madescens*, and *P.* **minimus**. A short, broad epiproct is seen in *P.* **potosi** and *P.* **teutonicus** (Fig. 47). A nearly quadrate epiproct (Fig. 46) occurs in *P. australis* and *P.* **monticola**. The male epiproct and paraproct seem to offer little of taxonomic value.

This study is based on examination of 543 adult specimens. In addition to my own material, specimens from the following collections were examined: American Museum of Natural History (New York City), P. J. Chapman (Geneva, New York), G. E. Eertmoed (Chicago, Illinois), Illinois Natural History Survey (Urbana, Illinois), Snow Entomological Museum (Lawrence, Kansas), United States National Museum (Washington, D. C.), and S. K. Wong (Levin, New Zealand).

Peripsocus **alachuae** n.sp.

DIAGNOSIS. Female subgenital plate (Fig. 39) with a single median inner sclerite, the sclerite approximately pentagonal in form and lacking a field of granules. Forewing markings (Fig. 3) relatively pale, showing large colorless areas. Male clunial process (Fig. 24) with lateral flanges.

MALE. Measurements, Table I.

MORPHOLOGY. Phallosome (Fig. 22) with base rounded, sides approximately parallel but wider apart in distal than in basal half; distal process short and broad at apex; lateral processes slender, straight but bent at their apices. Radular fork (Fig. 23) with main body a broad triangle; arms long, slender, curved inward. Clunial process (Fig. 24) with broad lateral flanges bearing no denticles.

COLOR (in alcohol). Body same as described for *P. alboguttatus* except dull yellowish-brown areas more extensive; thoracic pleura mostly of this shade. Wings marked as in female (see Fig. 3 and description of female).

Table I. Measurements, Ratios, and Ctenidial counts for species of the *Peripsocus alboguttatus* group. IO/D, Least head width between eyes divided by greatest antero-posterior diameter of an eye in dorsal view of head; PO, transverse eye diameter divided by greatest antero-posterior eye diameter in dorsal view of head.

	Forewing length (mm)	Length of hind tibia (mm)	Length of hind tarsal segment 1 (μ)	Length of hind tarsal segment 1 (μ)	Number of ctenidia, hind tarsal segment 1	IO/D	PO
Peripsocus **alachuae** n.sp., ♂							
Sample size	6	6	6	6	6	5	5
Minimum	1.97	0.63	194	97	14	0.83	0.78
Maximum	2.26	0.73	212	105	16	0.97	0.87
Mean	2.17	0.67	205	102	15	0.91	0.83
S.D.	0.10	0.04	8.5	3.0	0.8	0.07	0.04
Peripsocus **alachuae** n.sp., ♀							
Sample size	6	6	6	6	6	6	6
Minimum	1.78	0.60	184	100	11	1.92	0.67
Maximum	2.19	0.74	211	115	15	2.36	0.76
Mean	2.00	0.67	195	109	13	2.17	0.72
S.D.	0.16	0.05	10.6	5.4	1.4	0.21	0.03
Peripsocus alboguttatus Dalman, ♀, Eastern U.S.							
Sample size	10	10	10	10	10	10	10
Minimum	2.24	0.77	228	116	13	1.88	0.67
Maximum	2.75	0.89	275	143	16	2.30	0.75
Mean	2.55	0.83	253	131	14	2.16	0.72
S.D.	0.16	0.04	13.3	8.6	0.8	0.12	0.03
Peripsocus alboguttatus Dalman, ♂, Western U.S.							
One specimen	2.30	0.76	235	100	17	1.45	0.76
Peripsocus alboguttatus Dalman, ♀, Western U.S.							
Sample size	10	10	10	10	10	10	10
Minimum	2.12	0.76	233	117	10	2.36	0.67
Maximum	2.63	0.92	273	135	17	2.67	0.77
Mean	2.36	0.83	249	125	13	2.51	0.71
S.D.	0.19	0.01	12.2	6.4	2.7	0.12	0.03
Peripsocus **australis** n.sp., ♂							
Sample size	6	6	6	6	6	6	6
Minimum	2.37	0.79	253	107	15	0.55	0.79
Maximum	2.60	0.88	287	115	20	0.71	0.89
Mean	2.52	0.85	269	112	17	0.62	0.83
S.D.	0.09	0.03	14.9	2.9	1.7	0.06	0.03
Peripsocus **australis** n.sp., ♀							
Sample size	10	10	10	10	10	10	10
Minimum	2.35	0.75	216	109	11	1.82	0.63
Maximum	2.55	0.86	249	123	18	2.03	0.75
Mean	2.46	0.81	238	117	15	1.96	0.69
S.D.	0.06	0.04	10.8	3.7	2.1	0.06	0.04

TABLE I. (*Continued*)

	Forewing length (mm)	Length of hind tibia (mm)	Length of hind tarsal segment 1 (μ)	Length of hind tarsal segment 1 (μ)	Number of ctenidia, hind tarsal segment 1	IO/D	PO
Peripsocus **maculosus** n.sp., ♀, Northern form							
Sample size	28	28	28	28	28	28	28
Minimum	2.22	0.73	200	106	11	2.13	0.64
Maximum	2.75	0.96	280	144	16	2.51	0.74
Mean	2.52	0.88	253	130	13	2.27	0.70
S.D.	0.15	0.07	18.4	9.6	1.5	0.10	0.03
Peripsocus **maculosus** n.sp., ♀, intermediate form							
Sample size	4	4	4	4	4	4	4
Minimum	2.08	0.78	238	115	13	2.00	0.72
Maximum	2.40	0.84	251	123	14	2.15	0.75
Mean	2.24	0.81	245	119	14	2.08	0.73
S.D.	0.13	0.03	6.7	4.1	0.5	0.06	0.01
Peripsocus **maculosus** n.sp., ♀, Southern form							
Sample size	16	16	16	16	16	16	16
Minimum	1.60	0.55	179	97	11	1.94	0.69
Maximum	2.16	0.79	251	127	15	2.23	0.80
Mean	1.84	0.66	212	109	13	2.07	0.75
S.D.	0.17	0.07	19.2	8.1	1.1	0.09	0.03
Peripsocus madescens (Walsh), ♂, U.S.							
Sample size	5	5	5	5	5	5	5
Minimum	1.82	0.68	206	100	14	1.74	0.76
Maximum	2.01	0.72	233	108	17	1.79	0.80
Mean	1.92	0.70	218	103	15	1.77	0.78
S.D.	0.08	0.01	12.4	3.6	1.1	0.03	0.01
Peripsocus madescens (Walsh), ♀, U.S.							
Sample size	10	10	10	10	10	9	9
Minimum	2.17	0.77	208	107	12	2.13	0.68
Maximum	2.77	0.99	266	134	15	2.55	0.76
Mean	2.38	0.84	241	127	14	2.36	0.73
S.D.	0.17	0.06	17.4	7.7	1.1	0.13	0.02
Peripsocus madescens (Walsh), ♂, Mexico							
Sample size	3	3	3	3	3	2	2
Minimum	1.62	0.61	189	104	13	1.78	0.76
Maximum	1.72	0.62	210	110	16	1.89	0.78
Mean	1.66	0.62	201	107	14	1.83	0.77
S.D.	0.05	0.01	11.0	3.1	1.5	0.08	0.01
Peripsocus madescens (Walsh), ♀, Mexico							
One specimen	1.68	0.64	193	112	11	—	—
Peripsocus **minimus** n.sp., ♂							
Sample size	8	9	9	9	9	9	9
Minimum	1.96	0.62	207	100	14	0.84	0.77
Maximum	2.12	0.71	233	115	18	0.98	0.88
Mean	2.05	0.68	220	106	16	0.92	0.82
S.D.	0.05	0.01	9.2	5.9	1.2	0.04	0.03

Table I. (*Continued*)

	Forewing length (mm)	Length of hind tibia (mm)	Length of hind tarsal segment 1 (μ)	Length of hind tarsal segment 1 (μ)	Number of ctenidia, hind tarsal segment 1	IO/D	PO
Peripsocus **minimus** n.sp., ♀							
Sample size	11	11	11	11	11	10	10
Minimum	1.68	0.61	189	104	9	2.06	0.65
Maximum	2.08	0.68	217	123	14	2.28	0.74
Mean	1.96	0.64	199	113	12	2.17	0.68
S.D.	0.11	0.03	9.0	5.2	1.3	0.08	0.02
Peripsocus **monticola** n.sp., ♂							
One specimen	2.56	0.94	275	116	17	0.96	0.78
Peripsocus **monticola** n.sp., ♀							
Two	2.71	1.08	304	138	18	2.86	0.69
Specimens	2.66	1.05	296	129	16	2.81	0.64
Peripsocus **potosi** n.sp., ♀, Jamaica, W. I.							
Two	2.25	0.78	227	107	13	2.00	0.65
Specimens	2.15	0.70	200	103	12	2.01	0.69
Peripsocus **potosi** n.sp., ♀, Mexico							
Sample size	12	12	12	12	12	12	12
Minimum	1.88	0.64	181	100	12	1.86	0.61
Maximum	2.30	0.72	215	115	16	1.96	0.69
Mean	2.09	0.67	206	106	14	1.90	0.66
S.D.	0.10	0.02	9.3	1.2	1.3	0.03	0.03
Peripsocus **potosi** n.sp., ♀, Puerto Rico							
Sample size	11	11	11	11	11	11	11
Minimum	2.19	0.73	208	110	10	1.84	0.66
Maximum	2.34	0.78	233	128	15	2.07	0.78
Mean	2.28	0.76	223	120	12	1.93	0.72
S.D.	0.04	0.02	8.3	6.0	1.4	0.08	0.03
Peripsocus **potosi** n.sp., ♀, Trinidad, W. I.							
Two	2.13	0.70	204	109	11	1.86	0.68
Specimens	2.18	0.68	205	113	12	2.01	0.67
Peripsocus **teutonicus** n.sp., ♀							
Sample size	11	11	11	11	11	11	11
Minimum	2.35	0.79	219	118	10	1.94	0.68
Maximum	2.59	0.87	247	136	14	2.21	0.74
Mean	2.47	0.82	235	129	12	2.08	0.70
S.D.	0.08	0.02	8.4	5.9	1.3	0.09	0.02

FEMALE. Measurements, Table I.

MORPHOLOGY. Subgenital plate (Fig. 39) with apical process decidedly broader at base than long, abruptly tapering to rounded apex; pigmented area of face of plate quadrate with arms directed antero-laterally, straight; a median lobe directed forward between bases of arms; setae scattered over face of plate and median pigment lobe. Gonapophyses (Fig. 40): first valvula decidedly arched ventrally, its apex abruptly pointed; second valvula somewhat tapering toward apex; third valvula with apex broadly rounded and directed posteriorly.

COLOR (in alcohol). Body coloration as in male. Forewing markings (Fig. 3): Pterostigma pale or with a dark distal spot; first dark transverse row scarcely visible; second dark transverse row lacking spot no. 1 or with it very small; third dark transverse row exceedingly pale or absent; outer dark radial arc absent or represented by spots no. 2 and 3. Hindwings unmarked.

RANGE. State of Florida, not yet recorded from southern third of peninsula.

TYPE LOCALITY. Archbold Biological Station, Highlands County, Florida, February 13, 1967, light trap, S. W. Frost, holotype ♂, allotype ♀, and 2 ♂ paratypes. Types are in the author's collection.

RECORDS. Florida: Gainesville, March 13, 1963, black light trap, 1 ♀, H. A. Denmark; April 17, 1965, beating vegetation in pine-hardwoods forest, 1 ♂, E. L. Mockford and J. Manzano; 5 miles west of Gainesville on Highway 26, October 23, 1953, beating *Crataegus* and sifting *Crataegus* leaf litter, 2 ♂, E. L. Mockford; 14.6 miles north of Milton on Highway 87 (Santa Rosa County), August 21, 1951, 1 ♀, E. L. Mockford; Newnan's Lake, July 25, 1952, sweeping grasses, mostly *Andropogon,* 1 ♀, E. L. Mockford; Oleno State Park (Columbia County), March 26, 1953, beating shrubs in river swamp-xeric hammock transition area, 1 ♂, 2 ♀, E. L. Mockford; 7 miles south of Port Richey on Highway 19 (Pasco County), November 30, 1961, beating mostly laurel oak (*Quercus laurifolia* Michx.), 1 ♀, E. L. Mockford and R. O. Rilett.

Peripsocus alboguttatus (Dalman)

Psocus alboguttatus Dalman, 1823: 98.

Complete synonymy in Smithers (1967: 68).

DIAGNOSIS. Larger species, forewings always greater than 2.1 mm. in length. Female subgenital plate with two distinctly separate inner sclerites. Form in eastern United States presumably parthenogenetic (males unknown), with forewing markings decidedly contrasty (Fig. 7); form in Pacific Northwest bisexual, forewing markings less contrasty than in eastern form (Fig. 8).

MALE. Measurements of North American material, Table I.

MORPHOLOGY. Phallosome (Fig. 19) with sides parallel, its distal process slender, not or scarcely widened at tip; lateral processes slender, each arising from a small, rounded sclerite. Radular fork (Fig. 20) with its main body in form of a broad triangle; arms straight. Clunial process (Fig. 21) with lateral flanges bearing a few minute denticles.

COLOR (in alcohol). Head medium brown except dull yellowish-white on genae and anterior third of vertex; labrum dark brown. Compound eyes and ocelli black. Antennae pale brown. Thoracic notal lobes medium dark brown, areas bordering sutures between lobes dull yellowish-white. Thoracic pleura and legs medium brown, sutures of pleura darker. Forewings marked as in female (Fig. 8) but less intensely. Hindwings unmarked. Preclunial segments of abdomen yellowish-white ringed with broken bands of purplish-brown subcuticular pigment. Terminal abdominal segments medium brown.

FEMALE. Measurements, Table I.

MORPHOLOGY. Subgenital plate (Fig. 34) with apical process slightly broader at base than long; pigmented arms wide, diverging strongly, slightly curved; setae scattered through broad central region and across posterior third of face of plate. Gonapophyses (Fig. 33): first valvula slightly arched ventrally, with a slender apex (as in Fig. 35 of *P.* **maculosus**) or not; second valvula with narrowed apex; third valvula rounded apically, the apex directed slightly ventrad.

COLOR (in alcohol). Body coloration same as in male except brown areas duskier.

Forewing marking characteristics for material from eastern United States: pterostigma uniformly dark throughout; first dark transverse row indistinct; in second dark transverse row, spot no. 4 uniformly dark; in second dark transverse row, spot no. 2 curved; in outer pale radial arc, all spots present but no. 3 indistinct; in outer dark radial arc, spot no. 1 small, no. 5 absent.

Forewing marking characteristics for material from Pacific Northwest differing from above as follows: in second dark transverse row, spot no. 5 very small or absent; in third dark transverse row, spot no. 1 very small or absent; in second pale transverse row, spot no. 2 variable; in outer pale radial arc, all spots present and large; in outer dark radial arc, all spots may be indistinct.

RANGE. Throughout most of Europe, including the British Isles; eastern United States, west in the north to western New York, south in the Appalachians to Tennessee; interior and coast of British Columbia, coastal Washington.

RECORDS. Eastern United States: Maine: Houlton (Aroostook County), August 26, 1925, 1 ♀, C. R. Crosby. Maryland: Cunningham Falls State Park (Frederick County), August 28, 1955, beating hemlock (*Tsuga canadensis* Carr.), 2 ♀, E. L. Mockford; Fishing Creek Reservoir (Frederick County), July 17, 1955, beating hemlock foliage, 1 ♀, E. L. Mockford. New Hampshire: Lafayette Camp near Franconia, September 21, 1956, 1 ♀, G. B. Wiggins. New York: Ballston Lake (Saratoga County), July 14, 1926, beating, 1 ♀, P. J. Chapman; Fair Haven (Cayuga County), September 7, 1924, 1 ♀; Hunter, August 16, 1925, beating, 5 ♀; Ithaca, Six Mile Creek, July 11, 1926, in dead leaves on tree, 3 ♀, P. J. Chapman; Little Valley (Cattaraugus County), September 17, 1925, 1 ♀, P. J. Chapman; McLean Reserve (Tompkins County), July 16, 1924, 1 ♀; Michigan Mills (Lewis County), September 1, 1926, beating mostly spruce (*Picea* sp.), 29 ♀, P. J. Chapman; Paul Smith's (Franklin County), August 31, 1927, beating mostly larch (*Laryx* sp.) and spruce, 38 ♀, P. J. Chapman. Tennessee: Great Smoky Mountains National Park, July 11, 1949, sweeping spruces, el. 5200 ft., 2 ♀, E. L. Mockford. West Virginia: Spruce Knob (Randolph County), October 8–9, 1955, 2 ♀, E. L. Mockford and M. A. Byrd.

Pacific Northwest: British Columbia: 16 miles north of Alexandria on Highway 97, August 2, 1963, beating conifers, 1 ♀, R. C. Rounds; 8.6 miles west of Endake on Highway 16, July 31, 1963, on spruce, 1 ♂, 4 ♀, R. C. Rounds and McCort; Vancouver, University of B. C., August 9, 1963, on broom (*Cystisus scoparius* (L.) Link), 4 ♀, R. C. Rounds. Washington: 8.7 miles east of Olympia on Highway 99 (Pierce County), June 28, 1963, beating alders (*Alnus* sp.) and maples (*Acer* sp.), 2 ♂, 1 ♀, 1 nymph, E. L. Mockford and F. Hill.

DISCUSSION. This species, which occurs throughout Europe, may have been introduced on the coast of Washington and adjacent British Columbia. Its introduction into eastern United States is considerably less likely, as it is apparently parthenogenetic there and its range seems to center on the Appalachian Mountains rather than on the coast.

Peripsocus **australis** n.sp.

DIAGNOSIS. Female subgenital plate (Fig. 48) without an inner sclerite but with a rounded, slightly thickened median region, this region bearing a central dark-staining field of granules. Forewing pattern (Fig. 11) relatively obscure; both inner and outer series of radial pale spots very indistinct beyond first two spots in each. Female gonapophyses (Fig. 49) with second valvula relatively long and slender; third valvula very short, with relatively heavy sclerotization around its margin. Male clunial process (Fig. 14) lacking flanges.

Differing from *P. balli* Badonnel by relatively shorter and broader apical process of subgenital plate, presence of lateral points on pigmented arms of subgenital plate, relatively broader second valvula of female gonapophyses.

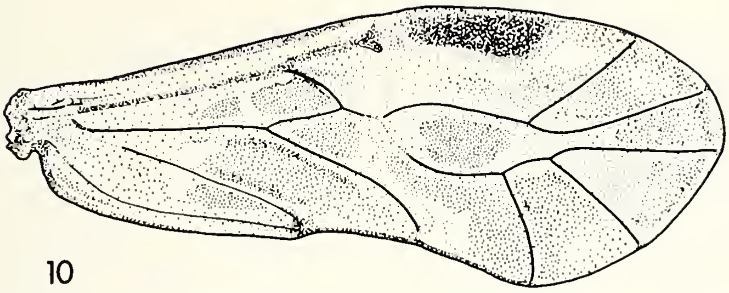
MALE. Measurements, Table I.

MORPHOLOGY. Phallosome (Fig. 13) with base rounded, sides parallel; distal process short, bilobed at tip; lateral processes strong, directed antero-laterally. Radular fork (Fig. 15) with slender, acuminate main body; broad, slightly curved arms. Clunial process (Fig. 14) lacking lateral flanges, subtended by a short, rounded process.

COLOR (in alcohol). Head and its appendages dusky brown except for a wide semicircle of pale brown with posterior arc on vertex around ocellar interval and including frontal part of fronto-clypeus. Ocellar interval dark brown, compound eyes black. Thorax as in *P. alboguttatus* but brown regions duskier. Forewings (Fig. 10) marked as in female except dark spots in general slightly paler. Hindwings unmarked, but with slight grayish-brown wash near apex. Abdomen with membranous portion white showing dorsally slight amounts of scattered purplish-brown subcuticular pigment and a narrow dorso-medial tergal band of cuticular pigment in each of segments 5, 6, and 7; sclerotized portions of terminal segments dusky brown.

→

FIGS. 10–18. Forewings and male genitalic parts of *Peripsocus alboguttatus* group species. Fig. 10. *P.* **australis** n.sp. ♂, forewing. Fig. 11. *P.* **australis** n.sp. ♀, forewing (scale of Fig. 10). Fig. 12. *P.* ***monticola*** n.sp. ♀, forewing (scale of Fig. 10). Fig. 13. *P.* **australis** n.sp. ♂, phallosome, damaged in mounting. Fig. 14. *P.* **australis** n.sp. ♂, clunial process. Fig. 15. *P.* **australis** n.sp. ♂, fork sclerite and associated endophallic structures. Fig. 16. *P.* **monticola** n.sp. ♂, phallosome (scale of Fig. 13). Fig. 17. *P.* **monticola** n.sp. ♂, clunial process. Fig. 18. *P.* **monticola** n.sp. ♂, fork sclerite and associated endophallic structures (scale of Fig. 15).



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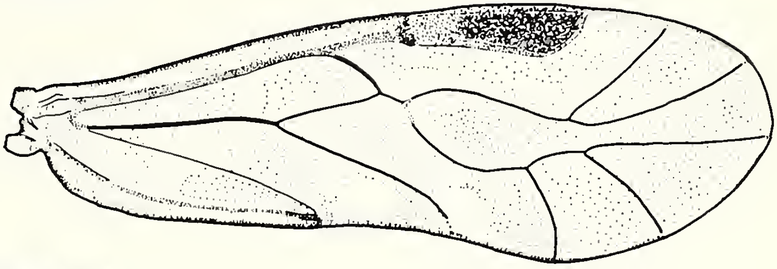

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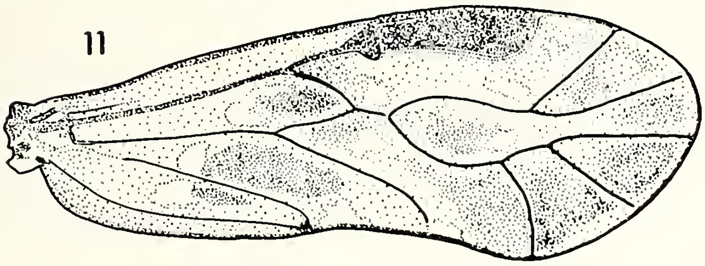

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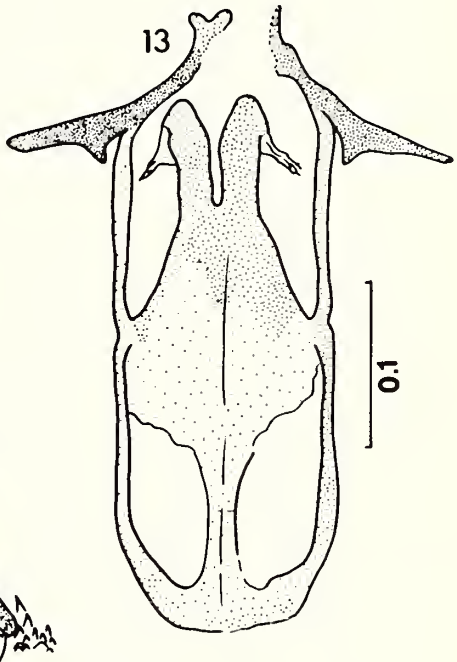

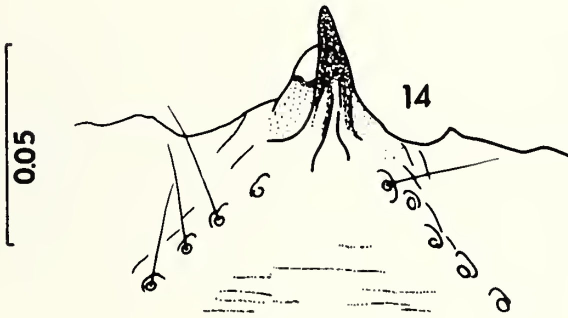

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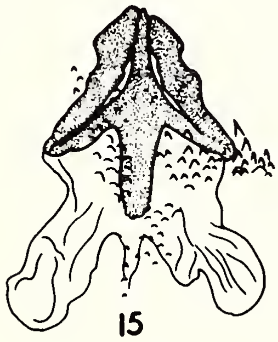

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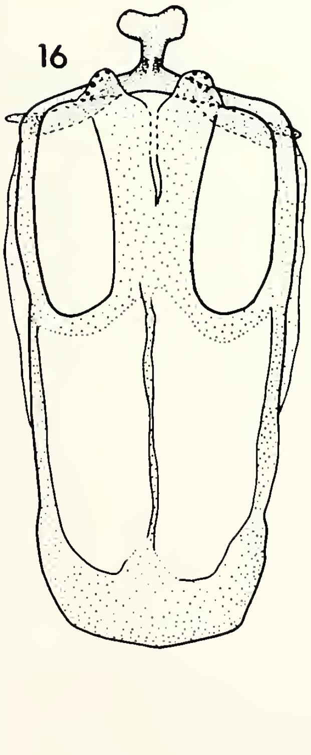

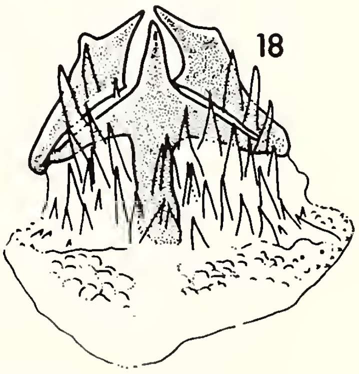

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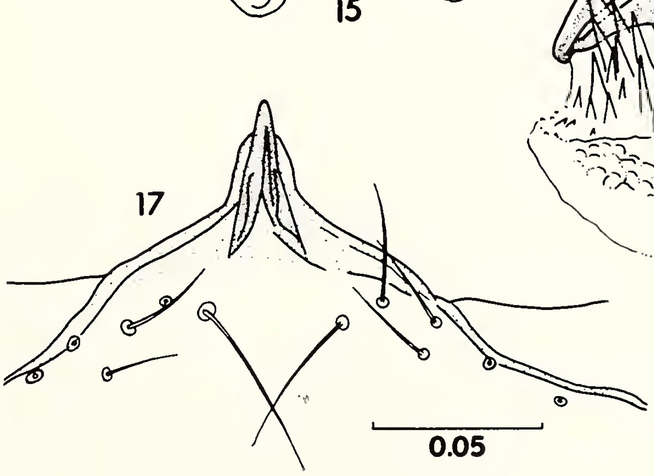

FEMALE. Measurements, Table I.

MORPHOLOGY. Subgenital plate (Fig. 48) with its apical process very slightly longer than its basal width; short setae scattered length of process; lateral arms of pigmented area diverging strongly then in their anterior third bending anteriorly, the pigment forming a lateral point at this bend; a slight median lobe visible between arms in stained material. Setae on face of subgenital plate concentrated mostly along bases of arms, some scattered on arms and on median lobe. Gonapophyses as described in diagnosis.

COLOR (in alcohol). Body essentially same as in male but pale area of vertex and frons nearly white and more extensive; genae of same color; membranous portions of abdomen somewhat more densely pigmented with purplish-brown subcuticular pigment; tergal bands absent on segments 5–7. Forewing markings (Fig. 11): pterostigma paler in basal third than in remainder with reflected light, nearly uniformly dark with transmitted light (the difference with transmitted light more pronounced in males); first dark transverse row absent, or spot no. 1 present; second dark transverse row with spot no. 1 obscure; third dark transverse row represented by spot no. 1, this spot continuous with dark spot no. 6 of the outer dark radial arc. Hindwings unmarked, washed with gray.

TYPE LOCALITY. Nova Teutonia, Santa Catarina, Brazil (27°11′ south, 52°23′ west), September and October, 1970, el. 300–500 m, Fritz Plaumann, holotype ♂, allotype ♀, 5 ♂ and 10 ♀ paratypes. Types be deposited in the United States National Museum.

Peripsocus balli Badonnel

Peripsocus balli Badonnel, 1948: 311.

Although I have seen no material of this species, comparison with Badonnel's detailed and superbly illustrated description allows one to conclude that a very close relationship exists between this species of the Congo Republic and the south Brazilian *P.* **australis** n.sp. In view of this relationship, it seems highly probable that the male tentatively assigned to *P. balli* by Badonnel (1969) represents another species, not a member of the *alboguttatus* group.

Peripsocus **maculosus** n.sp. (♀)

DIAGNOSIS. Female subgenital plate with a single median inner sclerite, the sclerite broader than long and showing slight indication of central division. Forewing marking pattern (Fig. 1) decidedly contrasty. Males unknown.

FEMALE. Measurements, Table I.

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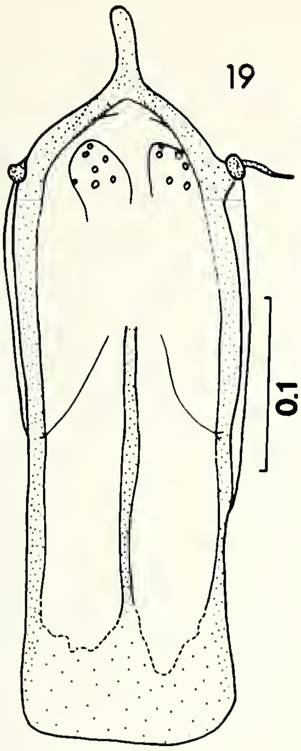
Figs. 19–27. Male genitalic parts of *Peripsocus alboguttatus* group species. Fig. 19. *P. alboguttatus* Dalman ♂, phallosome. Specimen from Pacific Northwest. Fig. 20. *P. alboguttatus* Dalman ♂, fork sclerite and associated endophallic structures (scale of Fig. 23). Fig. 21. *P. alboguttatus* Dalman ♂, clunial process. Fig. 22. *P.* **alachuae** n.sp. ♂, phallosome (scale of Fig. 19). Fig. 23. *P.* **alachuae** n.sp. ♂, fork sclerite and associated endophallic structures. Fig. 24. *P.* **alachuae** n.sp. ♂, clunial process (scale of Fig. 21). Fig. 25. *P. madescens* Walsh ♂, phallosome (scale of Fig. 19). Fig. 26. *P. madescens* Walsh ♂, clunial process (scale of Fig. 21). Fig. 27. *P. madescens* Walsh ♂, fork sclerite and associated endophallic structures (scale of Fig. 23).



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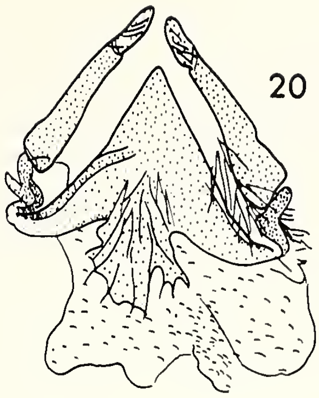

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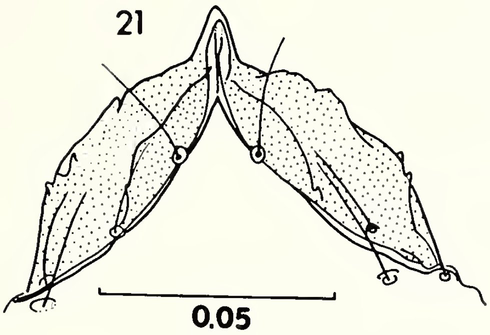

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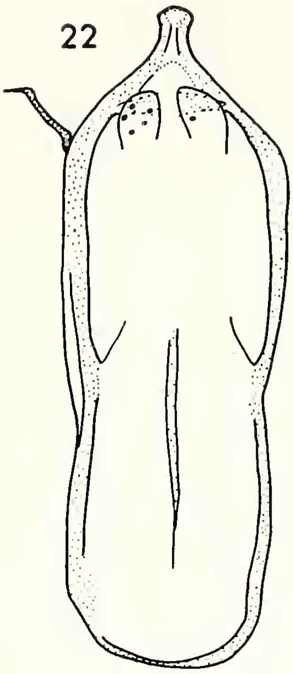

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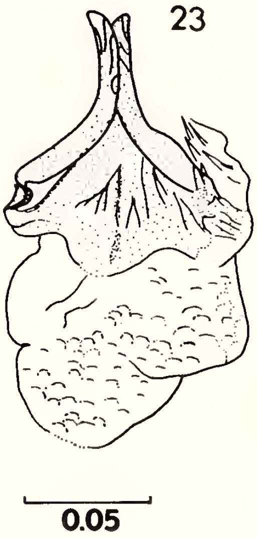

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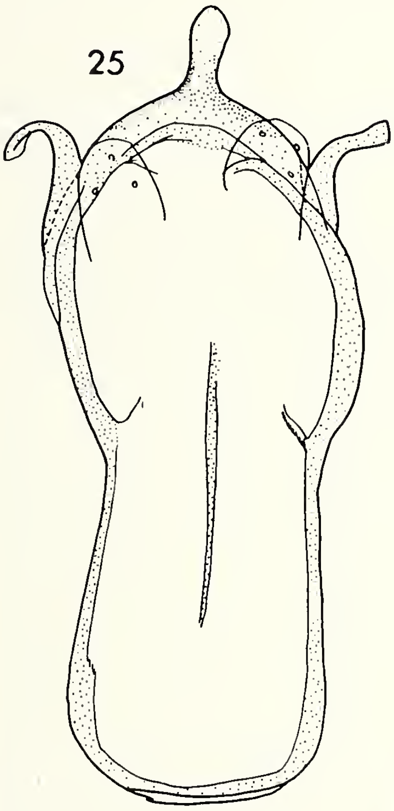

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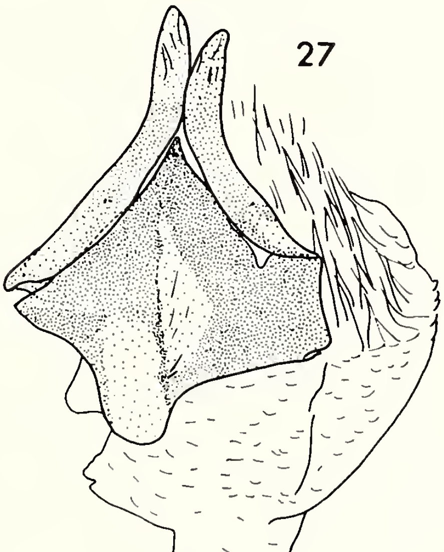

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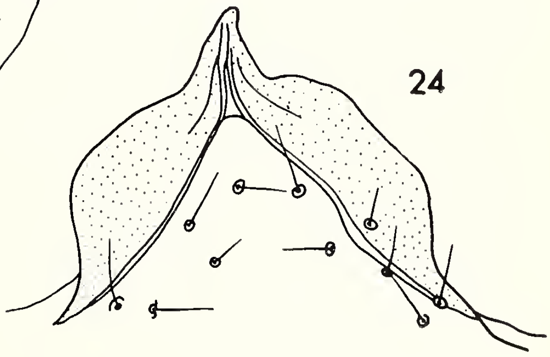

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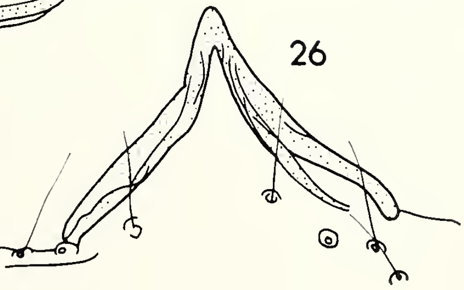

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MORPHOLOGY. Subgenital plate (Fig. 36) with apical process slightly broader at base than long; pigmented arms wide basally, decidedly tapering and curved outward toward their apices, a small pigmented lobe between the arms; setae mostly concentrated in a row across posterior third of face of plate, a few setae scattered over face of plate. Gonapophyses (Fig. 35): first valvula arched ventrally, with narrowed apex; second valvula slightly narrowed apically; third valvula rounded apically, its apex directed somewhat ventrad.

COLOR (in alcohol). Body coloration as described for *P. alboguttatus* male except dull yellowish-white area of vertex more extensive, entire ocellar interval dark brown. Forewing markings (Fig. 1): pterostigma paler basally than distally; first dark transverse row distinct; spot no. 2 of second pale transverse row a straight, narrow, transversely-oriented band; in outer dark radial arc, spots no. 1 and 5 poorly developed or absent. Hindwing with a brown wash at wing apex and at apex of cell Cu_2, otherwise unmarked.

RANGE. Eastern United States and southeastern Canada.

TYPE LOCALITY. Lagrange County, Indiana, U. S. Highway 20, 8 miles west of Lagrange, July 6, 1956, beating larches (*Laryx laricina* Koch), E. L. Mockford, holotype ♀, 12 ♀ paratypes, and 4 nymphs. Types are in the author's collection.

RECORDS. Canada: Quebec: near Mascouche on Highway 18 (L'Assomption County), August 21, 1956, beating spruce, 5 ♀, beating branches of broad-leaved trees, 1 ♀, E. L. Mockford; near Sainte Julienne on Highway 18 (L'Assomption County), August 21, 1956, beating conifers, 3 ♀, E. L. Mockford. United States: Arkansas: Drew County, June 15, 1967, 1 ♀, I. Brown. Florida: The Glen (Marion County), March 6, 1927, 8 ♀, M. D. Leonard. Illinois: Mundelein (Lake County), July 26, 1959, beating conifers, 2 ♀, E. L. Mockford and J. Mathieu; Pine Hills Recreation Area (Union County), September 20, 1959, beating oaks (*Quercus* spp.), 1 ♀, E. L. Mockford; Pounds Hollow Recreation Area (Gallatin County), June 29, 1958, beating *Pinus echinata* Mill., 1 ♀, July 18, 1959, beating *P. echinata*, mostly dead branches, 12 ♀, 2 nymphs, E. L. Mockford. Indiana: Bloomington, October 29, 1949, *ex* pines (*Pinus* sp.), 3 ♀, E. L. Mockford; Clifty Falls State Park (Jefferson County), June 5, 1959, beating *Juniperus virginiana* L. on bluff, 1 ♀, E. L. Mockford. Michigan: Edwin S. George Reserve (Livingston County), July 8, 1956, beating *Vaccinium* and white oak (*Quercus alba* L.), 1 ♀, August 2, 1956, beating sumacs (*Rhus* sp.), 2 ♀, 4 nymphs, E. L. Mockford; Mud Lake Bog (Washtenaw County), July 20, 1956, beating black spruce, (*Picea mariana* B.S.P.), foliage and dead branches, 4 ♀, E. L. Mockford. Minnesota: Kabetogama Lake (St. Louis County), September 3–10, 1966, *ex Picea* sp., 3 ♀, J. Pinto. Mississippi: Chawalla Recreation Area near Potts Camp (Marshall County), June 16, 1970, beating junipers and pines, 2 ♀, E. L. Mockford and A. Manzano. Missouri: Fredricktown, June 12, 1969, beating *Juniperus virginiana*, 1 ♀, E. L. Mockford and J. Schaab; 7 miles south of Fredricktown on Highway 67, June 12, 1969, beating *Pinus echinata*, 1 ♀, 1 nymph, E. L. Mockford; 27 miles north of Poplar Bluff on Highway 67 (Wayne County), June 12, 1969, beating *Juniperus virginiana* on hillside, 3 ♀, E. L. Mockford. New York: Fredonia, July 21, 1946, 1 ♀, R. H. Beamer; Ithaca, August 6, 1926, beating, 1 ♀, P. J. Chapman; Ithaca, Six Mile Creek, September 6–26, 1926, 6 ♀, P. J. Chapman; Nigger Pond (Oswego County), September 3, 1926, 4 ♀, P. J. Chapman; Woodwardia Swamp (Tompkins County), August 10, 1924, 5 ♀. Virginia: Cumberland State Forest (Cumberland County), September 20, 1955, on dead *Pinus virginiana*, 44 ♀, 22 nymphs, M. A. Byrd. Wisconsin: 11 miles east and 4 miles south of Siren (Burnett County), August 6, 1966, 1 ♀, Dean Hansen.

DISCUSSION. Decided differences in size exist between material from near the northern edge of the known range and material from certain southern localities. The relationship does not seem to be one of a strict north-south size cline. The largest specimens are known from southern Michigan, northern Indiana, and western New York. Material from southern Quebec averages somewhat smaller. The smallest specimens are from extreme southern Illinois (Pound's Hollow Recreation Area, Gallatin County), and central Virginia (Cumberland County). Specimens from northern Mississippi and northern Florida average somewhat larger. Specimens from localities lying roughly between those of the largest and those of the smallest specimens are intermediate in size.

Peripsocus madescens Walsh

Psocus madescens Walsh, 1863: 186.

Complete synonymy in Smithers (1967: 69).

DIAGNOSIS. Female subgenital plate with a single median inner sclerite, the sclerite approximately quadrate in form and bearing near its posterior margin a field of dark-staining granules. Forewing markings (Fig. 9) contrasty. Male clunial process (Fig. 26) lacking lateral flanges.

MALE. Measurements, Table I.

MORPHOLOGY. Phallosome (Fig. 25) with sides approximately parallel in basal half, arched outward in distal half; distal process decidedly widened preapically; lateral processes decidedly curved. Radular fork (Fig. 27) with main body in form of broad triangle, its arms long and curved. Clunial process (Fig. 26) lacking lateral flanges.

COLOR (in alcohol). As described for *P. alboguttatus*, except entire ocellar interval dark brown, fronto-clypeus distinctly striated with medium-brown lines. Wings marked as in female (see Fig. 9 and female description).

FEMALE. Measurements, Table I.

MORPHOLOGY. Subgenital plate (Fig. 37) with apical process slightly broader at base than long; pigmented area of plate quadrate with slender arms curving antero-laterally and a median lobe between the arms; setae scattered over face of plate and median pigment lobe. Gonapophyses (Fig. 38): first valvula arched ventrally, with short narrowed apex; second valvula broad apically; third valvula with apex obtusely tapered, directed posteriorly.

COLOR (in alcohol). Body coloration same as in male. Forewing markings (Fig. 9): pterostigma paler basally than distally; in third dark transverse row, spot no. 1 small or absent; in second pale transverse row, spot no. 2 somewhat curved; in inner pale radial arc, spot no. 6 obscure or absent; in outer dark radial arc, spots no. 1, 4, and 5 obscure or absent. Hindwing with a slight brown wash at wing apex and apex of cell Cu_2, otherwise unmarked.

RANGE. Eastern United States in general, eastern Puebla and northern coast of Veracruz in Mexico.

TYPE LOCALITY. Near Rock Island, Illinois.

RECORDS. Mexico: Puebla: 4 miles northeast of Teziutlan, August 17, 1958, beating in cloud forest, 1 ♀, E. L. Mockford. Veracruz: 5 miles south of Tecolutla on coast, June 26, 1962, beating low strand vegetation, 5 ♂, 2 ♀, E. L. Mockford.

United States: Alabama: Mt. Cheaha, near Pulpit Rock (Cleburne County), August 19, 1951, *ex Pinus echinata*, 1 ♂, E. L. Mockford. Arkansas: Mt. Magazine (Logan County), July 15, 1949, 1 ♂, M. W. Sanderson and L. J. Stannard. Florida: Archbold Biological Station (Highlands County), February 13, 1967, light trap, 1 ♂, S. W. Frost; near Homestead, Everglades National Park Entrance, December 3, 1970, beating small palms and other vegetation, 2 ♂, 1 ♀, E. L. Mockford and A. Manzano; Otter Creek at Highway 24 (Levy County), November 8, 1953, beating trees and shrubs, 1 ♀, E. L. Mockford. Georgia: Hard Labor Creek State Park (Morgan County), September 1, 1951, swept from pine foliage, 1 ♀, E. L. Mockford; Macon, April 12, 1965, beating dried leaves on branches, 2 ♀, E. L. Mockford; Pearson (Atkinson County), September 1, 1951, sweeping shrubs, 1 ♀, E. L. Mockford; Tiger, October 18, 1926, 1 ♀, C. R. Crosby and S. C. Bishop. Illinois: Belleville, August 12, 1926, 1 ♀, C. R. Crosby; Mason State Forest (Mason County), July 2, 1961, beating dead pine branches on ground, 1 ♀, E. L. Mockford; 5 miles west of Pounds Hollow (Gallatin County), May 24, 1966, 2 ♀, J. K. Bouseman. Indiana: Bloomington, September 23–24, 1949, sweeping pines, 2 ♀, E. L. Mockford; Indianapolis, August 8, 1950, sweeping Scotch pine (*Pinus sylvestris* L.), 2 ♀, D. W. Rice; Oklandon, September 12, 1948, sweeping pines, 3 ♀, E. L. Mockford and D. W. Rice. Kentucky: McCracken County, September 17, 1938, from weeds in peach orchard, 1 ♂, W. F. Turner. Maine: Southwest Harbor, Mount Desert Island, August 8, 1937, 4 ♂. Michigan: Cheboygan County, August 22, 1955, 1 ♀; Edwin S. George Reserve (Livingston County), August 6, 1956, beating dead branches of broad-leaved trees, 2 ♀, E. L. Mockford; Midland County, June 24, 1952, 1 ♀, R. R. Dreisbach. Mississippi: 5 miles north of Ashland (Benton County), June 15, 1970, beating in mesophytic forest, 1 ♀, E. L. Mockford and A. Manzano; Chawalla Recreation Area near Potts Camp (Marshall County), June 16, 1970, beating junipers and pines, 1 ♀, E. L. Mockford. New Hampshire: Canaan, July 26, 1948, beating pines, 1 ♀, A. H. Sommerman. New York: Wellsville, September 15, 1925, 1 ♀, P. J. Chapman. North Carolina: Nelson, August 31, 1946, 1 ♀, L. D. Beamer. Virginia: Cumberland State Forest (Cumberland County), August 27, 1955, on dead Virginia pine, 1 ♀, 2 nymphs, M. A. Byrd.

DISCUSSION. The records under this name published by Chapman (1930) included primarily *P. alboguttatus* and *P.* **maculosus**, hence that author's suggestion of the possible synonymy of *P. madescens* and *P. alboguttatus.* Material tentatively assigned to this species in my list of Indiana psocids (Mockford, 1950: 198) is this species, except for the record from Bloomington, October 29, 1949, which is *P.* **maculosus**.

Chapman (1930) states that the types of this species are nonexistent. I have searched the following collections for them to no avail: Illinois Natural History Survey, Philadelphia Academy of Natural Sciences, Museum of Comparative Zoology, United States National Museum. I have found no information suggesting that they exist. Walsh's description places the species clearly in the *alboguttatus* group but contains nothing which will distinguish it from *P. alboguttatus* and *P.* **maculosus**. The type locality is designated as near Rock Island, Illinois.

I am designating as neotype a female specimen from Mason State Forest, Mason County, Illinois, located about 75 miles southeast of Rock Island. The neotype will be deposited in the United States National Museum.

Peripsocus **minimus** n.sp.

DIAGNOSIS. Small species, forewings less than 2.2 mm. in length. Female subgenital plate with two distinctly separate inner sclerites. Forewing marking pattern obscure (Fig. 4).

MALE. Measurements, Table I.

MORPHOLOGY. Phallosome (Fig. 28) with sides approximately parallel but somewhat tapering from base to tip; distal process slender, not widened at tip; lateral processes slender, recurved. Radular fork (Fig. 32) with main body in form of broadly quadrate base tapering rapidly to acuminate tip; arms straight, relatively short, only just meeting at tips. Clunial process (Fig. 30) with broad lateral flanges bearing no denticles.

COLOR (in alcohol). Head and thorax in general and their appendages slightly contrasting shades of pale brown and dull yellowish-white. Ocellar interval dark brown. Compound eyes bluish-gray in life, becoming black after several months in alcohol. Forewings marked as in female (Fig. 4 and description of female). Abdomen dull white except pale brown on terminal segments.

FEMALE. Measurements, Table I.

MORPHOLOGY. Subgenital plate (Fig. 31) with apical process decidedly broader at base than long, abruptly tapering to rounded apex; pigmented arms wide, diverging strongly, slightly curved; a pigmented tongue extending forward between arms; setae scattered over most of face of plate, somewhat concentrated in postero-median region. Gonapophyses (Fig. 29): first valvula very slightly arched ventrally, narrowing in apical fifth; second valvula with somewhat narrowed apex; third valvula relatively more densely pigmented around its margin than in its middle, with flat dorsal margin and rounded apex directed posteriorly.

COLOR (in alcohol). Body coloration as in male except segments of membranous portion of abdomen each with a transverse violet band of subcuticular pigment on each side, the bands on each of segments 5–7 extending over the entire tergum in a narrow, interrupted line. Subgenital plate and gonapophyses medium brown. Forewing markings (Fig. 4): pterostigma reflecting a paler shade than surrounding membrane but transmitting slightly darker; dark rows and arcs contrasting only slightly with their backgrounds; pale spots mostly obvious; spot no. 1 of first pale transverse row absent or only slightly developed; spot no. 3 of second pale transverse row obscure; entire outer pale radial arc obscure, the posterior three spots sometimes absent. Hindwing with a slight brown wash at its apex, otherwise unmarked.

RANGE. A band from southern Illinois southwestward to eastcentral Texas.

TYPE LOCALITY. Fredricktown, Missouri, June 12, 1969, beating foliage and branches of *Juniperus virginiana* in cemetery, E. L. Mockford and J. Schaab, holotype ♂, allotype ♀, 4 ♂, and 9 ♀ paratypes. Types are in the author's collection.

RECORDS. Arkansas: Blakely Mountain Area near Royal (Garland County), June 18, 1970, beating junipers, 7 ♂, 33 ♀, 13 nymphs, E. L. Mockford and T. Fassbender; Spring Lake near Belleville (Yell County), June 19, 1970, beating junipers, 1 ♂, 6 ♀, E. L. Mockford; 5 miles south of Washita on Highway 27 (Montgomery County), June 18, 1970, beating junipers, 1 ♂, 2 ♀, E. L. Mockford and T. Fassbender. Illinois: McLeansboro, May 24, 1959, on junipers, 3 ♂, E. L. Mockford. Missouri: 5 miles south of Festus on Highway 67, June 12, 1969, beating junipers, 4 ♂, 18 ♀, 5 nymphs, E. L. Mockford and J. Schaab; Norfork Lake at Tecumseh (Ozark County), June 13, 1969, 6 ♀, E. L. Mockford and J. Schaab; 27 miles north of Popular Bluff on Highway 67 (Wayne County), June 12, 1969, beating junipers, 1 ♂, 3 ♀, E. L. Mockford; Sam Baker State Park (Wayne County), June 20, 1959, beating junipers, 4 ♂, 5 ♀, E. L. Mockford. Texas: 2.5 miles north of Giddings on Highway 77 (Lee County), June 10, 1962, beating junipers, 1 ♂, 4 ♀, E. L. Mockford, F. Hill, and J. M. Campbell.

Peripsocus **monticola** n.sp.

DIAGNOSIS. Differing from all other species of the group in lacking completely the radial arcs of spots of the forewing. Female gonapophyses (Fig. 50) developed as in *P.* **australis**. Male clunial process (Fig. 17) lacking flanges.

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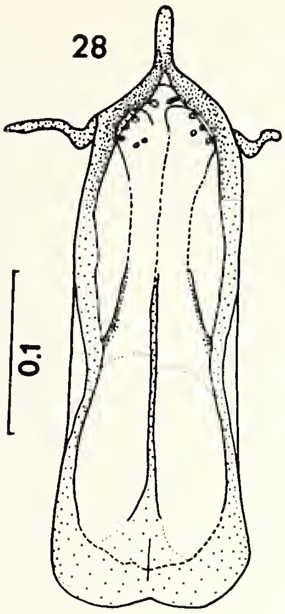
FIGS. 28–36. Male and female genitalic parts of *Peripsocus alboguttatus* group species. Fig. 28. *P.* **minimus** n.sp. ♂, phallosome. Fig. 29. *P.* **minimus** n.sp. ♀, gonapophyses. Fig. 30. *P.* **minimus** n.sp. ♂, clunial process. Fig. 31. *P.* **minimus** n.sp. ♀, subgenital plate. Fig. 32. *P.* **minimus** n.sp. ♂, fork sclerite and associated endophallic structures. Fig. 33. *P. alboguttatus* Dalman ♀, gonapophyses. Fig. 34. *P. alboguttatus* Dalman ♀, subgenital plate. Fig. 35. *P.* **maculosus** n.sp. ♀, gonapophyses. Fig. 36. *P.* **maculosus** n.sp. ♀, subgenital plate (scale of Fig. 34).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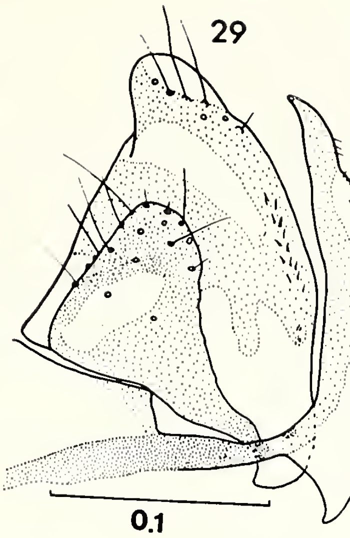
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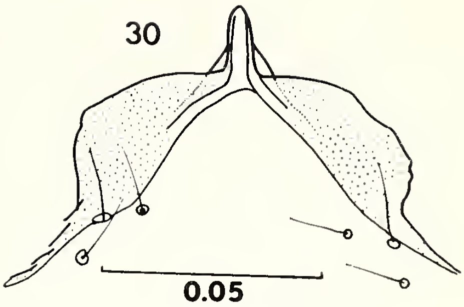
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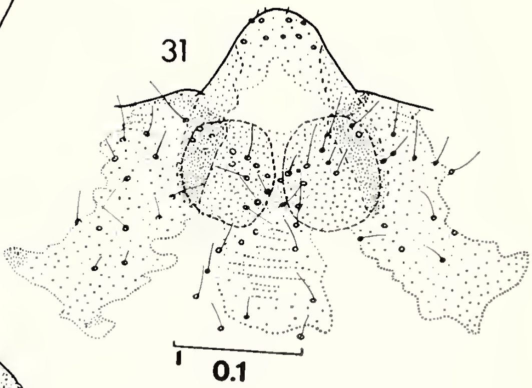
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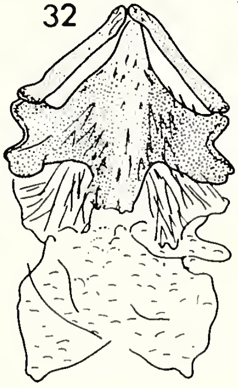
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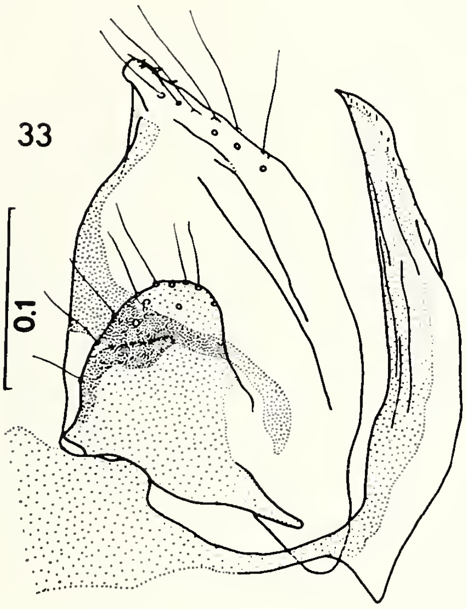
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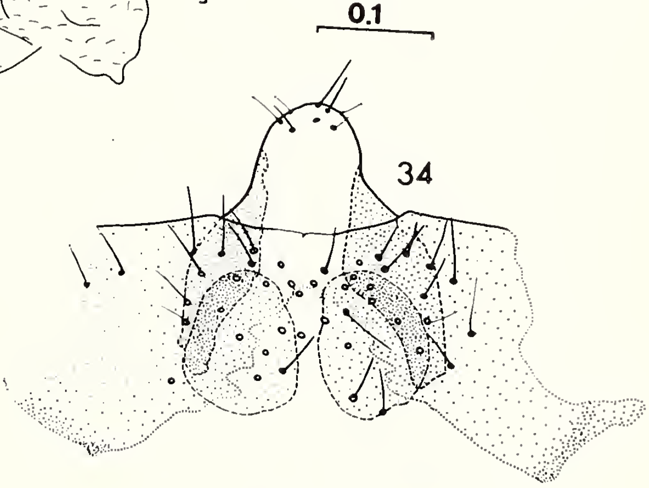
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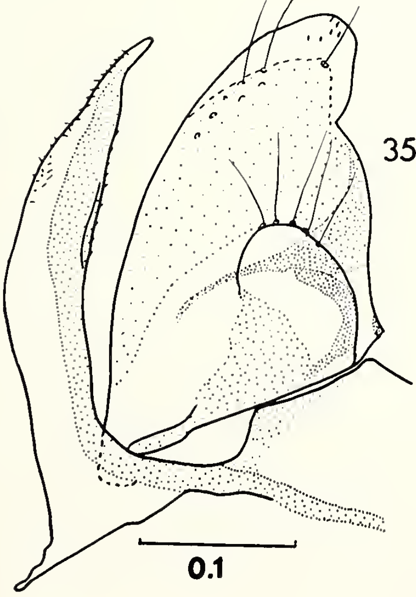
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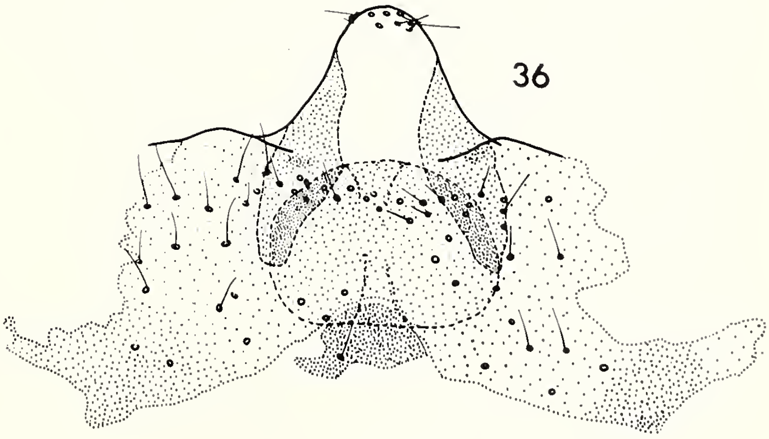
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MALE. Measurements, Table I.

MORPHOLOGY. Phallosome (Fig. 16) with base rounded, sides straight, slightly diverging from base to posterior end; distal process with wide, bilobed tip; lateral processes straight, furcated at tips, extending only very slightly beyond edges of phallosome proper. Radular sclerotizations (Fig. 18): fork sclerite with main body slender, acuminately pointed; arms straight, broad near their apices, becoming acuminately pointed at apices; more ventral sclerotizations in form of numerous long, slender denticles. Clunial process (Fig. 17) lacking lateral flanges, subtended by a shorter, rounded process.

COLOR (in alcohol). Body and appendages in general poorly contrasting shades of reddish-brown and dull yellowish-white with a reddish hue. Former color on head appendages, labrum, clypeal striations (these purple at their centers), posterior two-thirds of vertex, thoracic notal lobes (slightly darker here), tibiae, tarsi, and terminal abdominal appendages; latter color on genae, anterior third of vertex and adjacent frontal region, between thoracic notal lobes, on poorly sclerotized parts of thoracic pleura, and on legs from bases to distal ends of femora. Membranous portion of abdomen dull white with scattered patches of purplish-brown subcuticular pigment. A thin dusky-brown sclerotized strip across tergum 6, and another across tergum 7. Compound eyes black, ocellar interval dark brown. Wing markings as described for female.

FEMALE. Measurements, Table I.

MORPHOLOGY. Subgenital plate (Fig. 51) with its apical process much longer than its basal width; short setae scattered length of process; lateral arms of pigmented area diverging strongly, then in their anterior third bending anteriorly, the pigment forming a lateral point at this bend, a median pigment lobe present between arms in stained specimen; a small central field of dark-staining granules on plate. Setae on face of subgenital plate largely concentrated along a transverse line including bases of pigmented arms and on median pigmented lobe; a few setae scattered on arms. Gonapophyses (Fig. 50): first and second valvulae exceedingly long; first valvula straight, with acuminate tip beset with several short spines; second valvula slender most of its length, but with broad basal attachment to third valvula; third valvula exceedingly short, with a heavily sclerotized submarginal strip, bearing two long and several shorter setae.

COLOR (in alcohol). Similar in general to male, differing as follows: Vertex generally yellowish-white, with purple U-shaped mark, arms of U converging anteriorly on posterior margin of ocellar interval (such a mark exceedingly faint and much shorter on male); this mark setting off a pale orange band bordering epicranial suture to posterior head margin; purple pigment scattered in orange band and to sides of ocellar interval; fronto-clypeus with thin purple striations. Membranous portion of abdomen more generally marked with purplish-brown subcuticular pigment; no sclerotized strips on terga 6 and 7.

FOREWING MARKINGS (Fig. 12). Pterostigma paler in basal third than in remainder, the contrast greater with reflected than with transmitted light; first dark transverse row absent;

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FIGS. 37–44. Female genitalic parts of *Peripsocus alboguttatus* group species. Fig. 37. *P. madescens* Walsh ♀, subgenital plate (scale of Fig. 42). Fig. 38. *P. madescens* Walsh ♀, gonapophyses. Fig. 39. *P.* **alachuae** n.sp. ♀, subgenital plate (scale of Fig. 42). Fig. 40. *P.* **alachuae** n.sp. ♀, gonapophyses (scale of Fig. 41). Fig. 41. *P.* **potosi** n.sp. ♀, gonapophyses. Fig. 42. *P.* **potosi** n.sp. ♀, subgenital plate. Fig. 43. *P.* **teutonicus** n.sp. ♀, gonapophyses. Fig. 44. *P.* **teutonicus** n.sp. ♀, subgenital plate (scale of Fig. 42).

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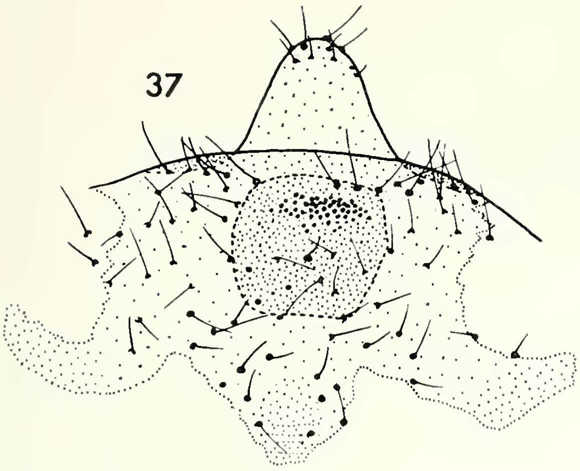

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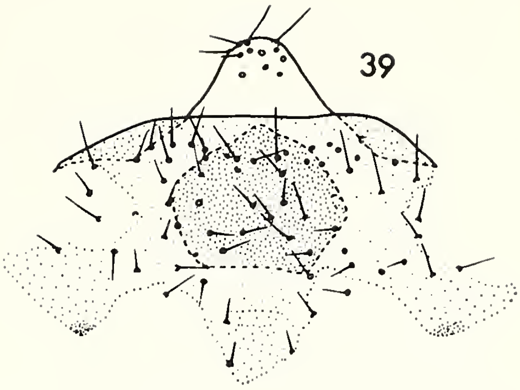

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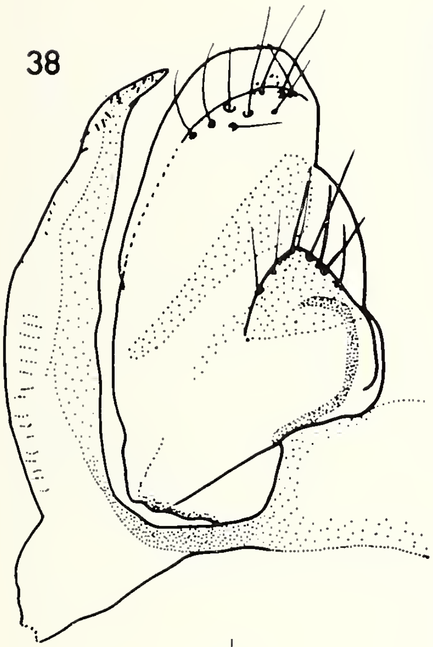

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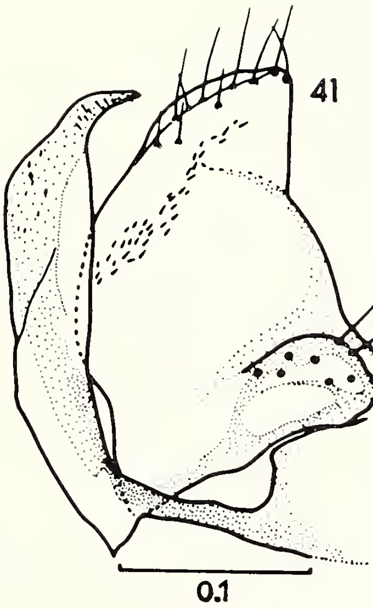

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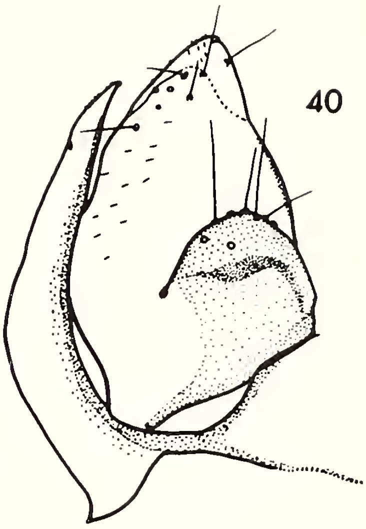

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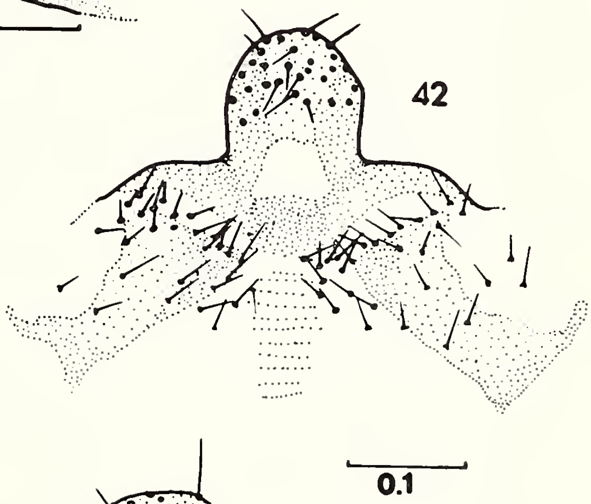

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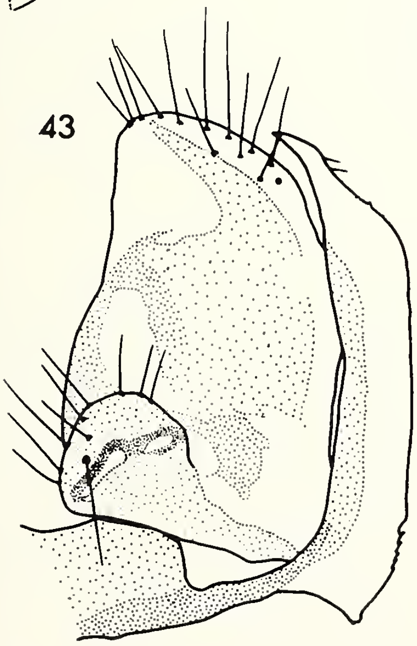

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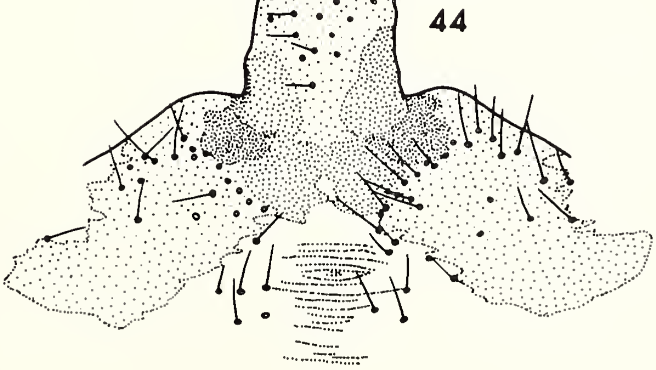


all other transverse rows present and continuous, i.e., not divided into discrete spots; region of radial arcs entirely of a uniform reddish-brown hue except cell R_1 pale distally. Hindwing with faint reddish-brown wash; in male, wash more prominent at wing apex and at apex of cell Cu_2; otherwise unmarked.

TYPE LOCALITY. Hardwar Gap, Jamaica, W. I., November 17, 1959, holotype ♂, allotype ♀, and 1 ♀ paratype, A. M. Nadler. Types will be deposited in the American Museum of Natural History.

Peripsocus **potosi** n.sp. (♀)

DIAGNOSIS. Female subgenital plate (Fig. 42) without an inner sclerite, but with median region slightly thickened. Forewing pattern (Fig. 5) with inner pale radial series of spots distinct and outer pale radial series represented by at least first three spots. Gonapophyses (Fig. 41) with second valvula relatively short and broad, of normal proportions for the genus; third valvula very short, with relatively heavy sclerotization around its margin. Male unknown.

FEMALE. Measurements, Table I.

MORPHOLOGY. Subgenital plate (Fig. 42) with apical process of same length as width at base, rounded, with short setae scattered over most of its surface. Lateral arms of pigmented area decidedly diverging, straight, a break in pigment at base of each arm; a slight median pigment lobe visible in stained material; setae concentrated mostly along bases of arms, a few scattered along arms. Gonapophyses (Fig. 41): first valvula very slightly arched ventrally, its apex decidedly curved upward and narrowed; second valvula somewhat narrowed in apical third; third valvula short, heavily pigmented (and sclerotized) around its margin, less so centrally.

COLOR (in alcohol). Head and its appendages uniformly pale brown except clypeus darker brown, ocellar interval and compound eyes black. Thoracic notal lobes medium brown, the sutures between lobes somewhat paler. Thoracic pleura pale purplish-brown; legs dull yellowish-white, slightly darker on tibiae. Abdomen with each preclunial segment ringed with a broad purplish-brown band, the bands obscure ventrally. Sclerotized portions of terminal segments medium brown. Forewing markings (Fig. 5): pterostigma pale in basal third, dark in distal two-thirds; first dark transverse row absent or only slightly developed; second dark transverse row spot no. 1 obscure; third dark transverse row absent; first pale transverse row almost continuous but with spot no. 1 obscure; second pale transverse row almost continuous; both dark radial arcs obscure, only spots no. 2 and 3 of both obvious. Hindwings unmarked.

RANGE. Central Mexico south to northern South America, island of Jamaica.

TYPE LOCALITY. Ejido Libertad, 1 mile southwest of Frontera, Tabasco, Mexico, March 17–18, 1964, *ex* coconut palms (*Cocos nucifera* L.), tamarind (*Tamarindus indica* L.), and native vegetation, E. L. Mockford and A. Manzano, holotype ♀, 14 ♀ paratypes, and 8 nymphs; same locality, March 31–April 1, 1964, beating broad-leaved trees and shrubs in rain forest, and planted trees, including coconut palms, 13 ♀ paratypes and 9 nymphs. Types are in the author's collection.

records. Colombia: Valle: Cali, September 3–4, 1970, light trap, el. 1000 m, 1 ♀, P. Barreto.

Costa Rica: Cartago, July 25, 1963, 3 ♀, D. E. Birkenholz.

Guatemala: 8–10 miles northeast of Guatemala City on Highway 4, August 27, 1968, beating oaks, long-needled pines, and miscellaneous shrubs and trees, 16 ♀, 7 nymphs, E. L. Mockford and A. Garcia Aldrete; 11 miles north of Salamá on Highway 5, August 29, 1968, beating broad-leaved shrubs and trees, 1 ♀, E. L. Mockford and A. Garcia Aldrete.

Mexico: Campeche: 13 miles east of Xpujil, March 28, 1964, beating dried palm leaves, 1 ♀, 1 nymph, E. L. Mockford and A. Manzano. Hidalgo: 5 miles south of Chapulhuacan on Highway 85, June 18, 1966, beating miscellaneous vegetation, 4 ♀, 5 nymphs, E. L. Mockford; 24 miles southeast of Rancho Viejo on Highway 85, June 22, 1962, beating vegetation in forest, 5 ♀, E. L. Mockford, F. Hill, and J. M. Campbell. Puebla: Finca Lourdes, La Union near Juarez, November 2, 1963, beating vegetation in forest 1 ♀, E. L. Mockford. San Luis Potosi: June 21, 1962, beating orange trees (*Citrus sinensis* Osbeck), 1 ♀, E. L. Mockford and F. Hill; El Salto, June 18, 1962, beating lemon tree (*Citrus limonum* (L.) Risso), 1 ♀, E. L. Mockford and F. Hill; Tamazunchale, June 18, 1966, beating *Sabal* palm, 1 ♀, 2 nymphs, E. L. Mockford and A. Manzano. Tabasco: 6 miles west of Macuspana, April 5, 1964, beating small trees in field, 1 ♀, E. L. Mockford; Rio Tonala on Highway 180, March 17, 1964, beating oil palms, 1 ♀, 10 nymphs, E. L. Mockford. Veracruz: 22.7 miles north of Alvarado on Highway 180, July 8, 1962, beating Australian pine (*Casuarina* sp.), 1 ♀, E. L. Mockford and F. Hill; 9.5 miles east of Orizaba on Highway 150, July 7, 1962, beating dried leaves on branches, 2 ♀, E. L. Mockford and J. M. Campbell; 5.8 miles east of Las Trancas on Highway 140, June 29, 1962, beating shrubs and trees, 1 ♀, E. L. Mockford and F. Hill.

Jamaica, W. I.: Kellits, Mason River Savanna (Clarendon Parish), April 16–17, 1959, 2 ♀, M. W. Sanderson.

Puerto Rico, W. I.: Rio Piedras, March 13–14, 1959, beating West Indian cherry (*Laurocerasus myrtifolia* (L.) Britt.), 12 ♀, E. L. Mockford.

Trinidad, W. I.: Piarco, March 1, 1959, beating low vegetation in forest, 2 ♀, E. L. Mockford.

Peripsocus **teutonicus** n.sp. (♀)

diagnosis. Female subgenital plate (Fig. 44) without an inner sclerite, but with median region slightly thickened. Forewing pattern (Fig. 6) with both inner and outer pale radial arcs of spots distinct and complete. Female gonapophyses (Fig. 43) with second valvula relatively short and broad, of normal proportions for the genus; third valvula somewhat shortened, bearing an inner pair of sclerotized loops. Male unknown.

female. Measurements, Table I.

morphology. Subgenital plate (Fig. 44) with apical process very slightly broader at base than long, its sides approximately parallel nearly to rounded apex, short setae scattered over most of its surface; lateral arms of pigmented area broad, strongly diverging, rounded apically; a slight pigmented lobe visible between arms in stained material; setae concentrated mostly along bases of pigment arms, a few scattered on rest of face of plate. Gonapophyses (Fig. 43): first valvula very slightly arched ventrally, its apex curved upward and narrowed. Second valvula broad apically; third valvula somewhat shortened, broadly rounded apically, bearing centrally two small regions of weak sclerotization and pigmentation surrounded, or nearly so, by a strongly sclerotized and pigmented rim.

COLOR (in alcohol). Head medium brown along epicranial suture and over entire frontoclypeus and antennae; remainder of head dull white except labrum and ocellar interval dark brown, compound eyes black. Thoracic notal lobes medium brown, the regions between lobes pale brown. Thoracic pleura and legs dusky medium brown. Preclunial abdominal segments ringed with purplish-brown bands, the rings interrupted ventrally. Terminal abdominal segments dusky medium brown. Forewing markings (Fig. 6): pterostigma paler in basal quarter than in remainder; dark transverse rows and radial arcs in general not distinguishable from background, but in some well-colored individuals spots of second dark transverse row and spots no. 2, 3, and 4 of inner dark radial arc visible; pale transverse rows forming almost continuous bands. Hindwings with grayish-brown wash bordering veins, around wing apex, and at apex of cell Cu_2, otherwise unmarked.

TYPE LOCALITY. Nova Teutonia, Santa Catarina, Brazil (27°11′ south, 52°11′ west), October–November, 1969, September–October, 1970, el. 300–500 m, Fritz Plaumann, holotype ♀ and 28 ♀ paratypes. Types will be deposited in the United States National Museum.

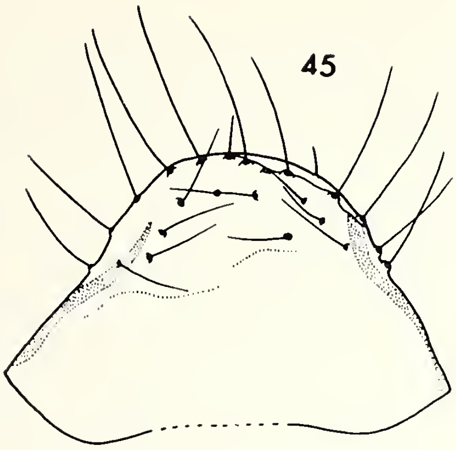
Phylogenetic Relationships in the *Alboguttatus* Group

Absence of a scheme of classification for the genus as a whole, and lack of detailed morphological information for many species make phylogenetic speculation on the *alboguttatus* group exceedingly difficult at this time. Certain probable phylogenetic relationships do appear among the species, however, and these will be discussed.

First, one must consider relationships to several species apparently outside of the group. *P. africanus* Enderlein and a closely related species tentatively identified as the males of *P. balli* by Badonnel (1969) show a wing marking pattern very similar to that described for most species of the *alboguttatus* group. These two species differ markedly, however, in male genitalic features (their females are presumably unknown) from any *alboguttatus*-group species. Both have a clunial comb of numerous denticles, and in both the principal endophallic sclerotizations form two lateral groups apparently not joined medially. The phallosome in general is not dissimilar in shape to that seen in most members of

→

Figs. 45–51. Female genitalic parts of *Peripsocus alboguttatus* group species. Fig. 45. *P. madescens* Walsh ♀, epiproct, (scale of Fig. 47). Fig. 46. *P.* **monticola** n.sp. ♀, epiproct, (scale of Fig. 50). Fig. 47. *P.* **potosi** n.sp. ♀, epiproct. Fig. 48. *P.* **australis** n.sp. ♀, subgenital plate. Fig. 49. *P.* **australis** n.sp. ♀, gonapophyses. Fig. 50. *P.* **monticola** n.sp. ♀, gonapophyses. Fig. 51. *P.* **monticola** n.sp. ♀, subgenital plate, (scale of Fig. 48).



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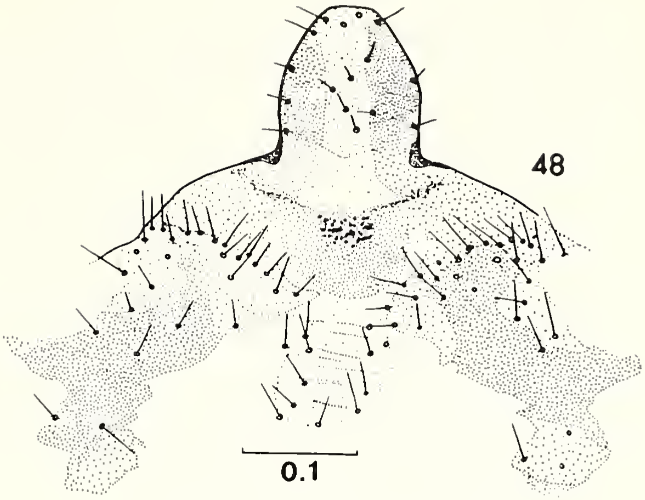

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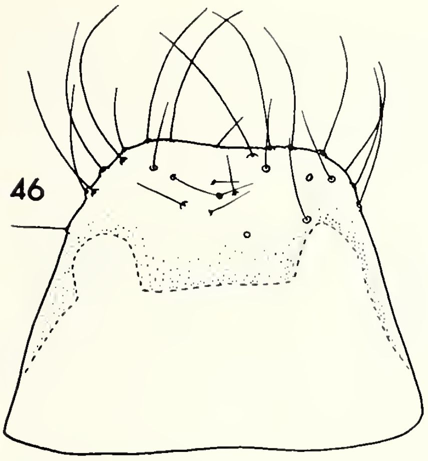

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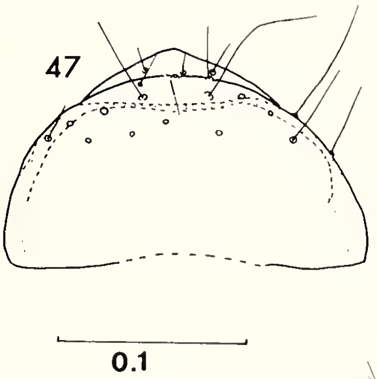

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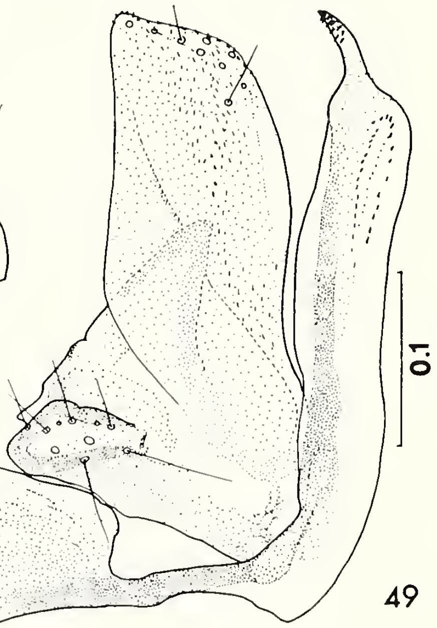

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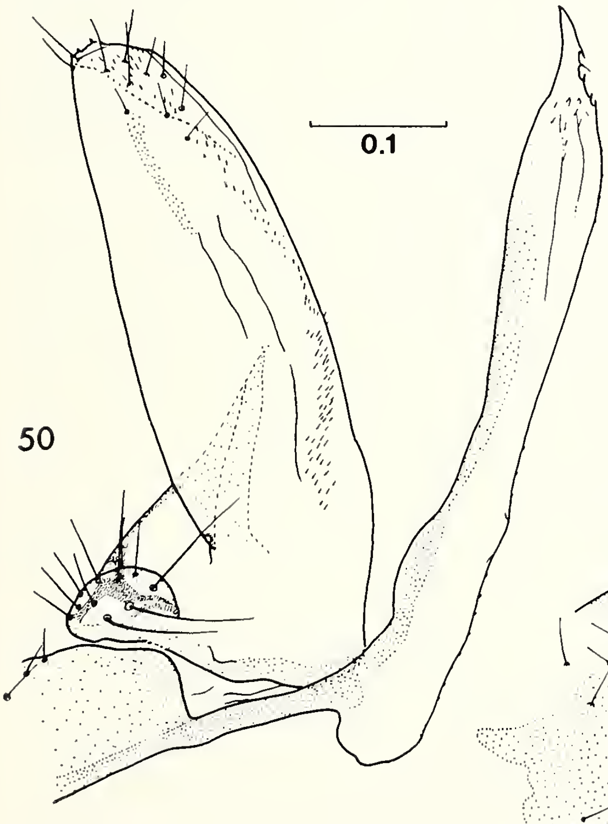

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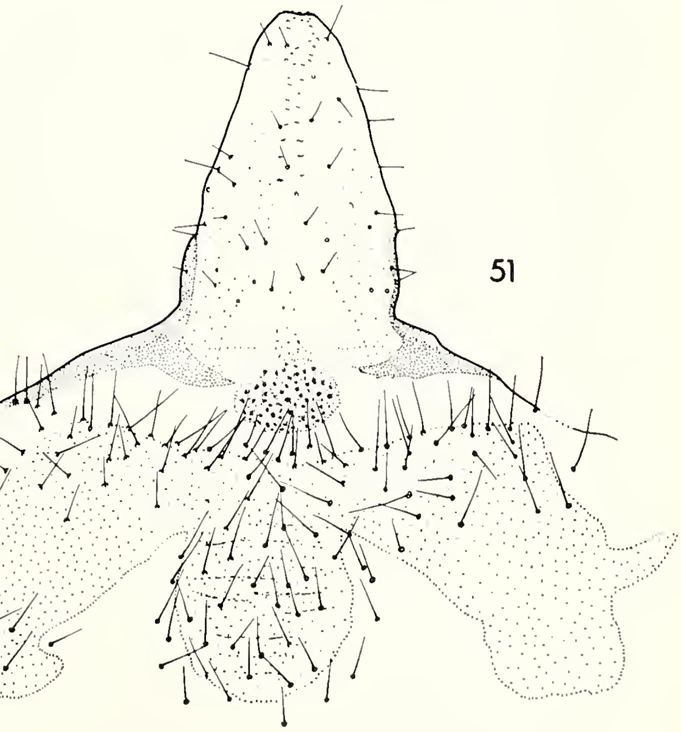

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the *alboguttatus* group. It would appear that these two species are not particularly closely related to any extant member of the *alboguttatus* group, but they may be rather close to the common ancestor of the group. In this case, the elaborate wing-marking pattern seen in most members of the group is probably primitive for the entire group.

Marked similarity is seen in structure of the female subgenital plate and gonapophyses between *P.* **monticola** and *P. quadripunctatus* Badonnel. The wing marking patterns of the two species are very different, and *P. quadripunctatus* does not share the extremely small size of third valvula with *P.* **monticola** and its close relatives *P.* **australis** and *P. balli*. One can suspect convergence in genitalic features in this case. Perhaps the problem can be solved if the male of *P. quadripunctatus* is found.

Apparently it is impossible to decide at present what species stand closest to the *alboguttatus* group, hence one cannot establish directions of evolution within the group. On the basis of morphology as well as geographic distribution, the southern cluster of species, *P.* **australis**, *P. balli*, and *P.* **monticola**, appears to represent one "end" of the group, while the northern species cluster including *P.* **alachuae**, *P. alboguttatus, P.* **maculosus**, *P. madescens*, and *P.* **minimus** seems to represent the other. Between these two clusters, *P.* **potosi** and *P.* **teutonicus** appear to be intermediates, the former species having a clearly intermediate distribution.

The southern species cluster appears to show a relictual distribution, with one species in southern Brazil, one in the Congo Republic, and one in a highland area of Jamaica. This suggests great antiquity for the cluster, but on the basis of female genitalic structure, which appears to be highly specialized for the genus, this cluster probably does not stand close to the primitive end of the species group.

Within the northern cluster, *P. madescens* and *P.* **alachuae** are apparently very closely related, the female genitalia being about the same in both, and these being the only two species in which the arms of the fork sclerite are decidedly curved. The other three species appear to be closely related among themselves.

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BOOK REVIEWS

The Bionomics of Blister Beetles of the Genus *Meloe* and a Classification of the New World Species. John D. Pinto and Richard B. Selander. 1970 (Feb. 26). Illinois Biological Monographs No. 42. University of Illinois Press, Urbana, Chicago and London. 223 pp. $10.00.

For several years Selander and his students at the University of Illinois have been doing excellent systematic and biological work on the beetles of the family Meloidae. In this latest contribution the Tribe Meloini is covered. The Tribe is defined to include the Genus *Meloe* and a Genus, *Spastonyx*, elevated and transferred, primarily on characters of the larvae, from its former position as a Subgenus of *Eupompha* in the Lyttini. Both genera are discussed in the bionomics section, while in the taxonomic section *Meloe* is covered both as adults and larvae and *Spastonyx* only as larvae of *S. nemognathoides* (Horn). The title is somewhat misleading in including only *Meloe*.

The genus *Meloe* contains 146 described species, of which the 23 from the New World are treated. Seven of these are described as new and five names are newly placed in synonymy. The taxonomic section includes a direct key to species and indirect keys by way of the three New World subgenera, species groups and subgroups. Each species is treated in standard taxonomic fashion including distribution maps and illustrations of many diagnostic characters. Photographs of heads and pronota display the usual limitations of photographs in taxonomic work but are perhaps a good way to illustrate differences in punctuation and sculpture.

In addition to extensively reviewing the literature (the bibliography contains nearly 200 titles) on the 26 world species for which some biological information is available, the authors include original field and laboratory investigations on six species, mostly from Illinois. Particularly valuable are the extensive sections on sexual behavior and on ontogeny. Courtship was observed in the laboratory for *M. laevis*, *angusticollis*, *dianella* and *impressus*, and good diagrams illustrate the differences in emphasis on different courtship activities in the latter three species. Additional species were observed less extensively. Rearings of *M. dianella* and *M. laevis* were carried through to the adult, and four other species were studied alive through part of the life history. Seasonal and host relations of the four species found at Fox Ridge State Park, Illinois, are compared.

David C. Miller

Butterflies of Trinidad and Tobago. Malcolm Barcant. 1970. 314 pp., 28 plates (16 in color), text figs. Collins, London. £. 275 p. (55s.).

This comprehensive book will be welcomed by all people interested in butterflies, especially in those of the Neotropical region, because of the wealth of natural history information contained in it. A total of 387 species are covered, of which 356 are illustrated, 241 of these in color. This includes all of the true butterflies (Papilionoidea), but omits the enormous and lesser known group of 230 skippers (Hesperioidea). For each species information is given, when known, about: range, description and identification, habits, habitat, abundance and variations. Preliminary sections give general information about butterfly life histories, structures, naming, ecology, and collecting and preserving specimens. A valuable section briefly describes past collecting in Trinidad and gives in detail the best seasons and localities for collecting. Many man-made changes in the environment and their effects on butterflies are discussed. Other points covered in separate parts are abundance and rarity, answers to popular questions, stray species, doubtful or erroneous records, favorite flowers of adults, and a complete checklist of all butterflies and skippers. There is, in fact, scarcely any imaginable facet of knowledge about the butterflies of the region that is not mentioned and discussed.

An unusual feature of the book is the arrangement of the species, both in the main part, where they are described and discussed individually, and in the color plates, where they are somewhat differently arranged. Instead of the conventional taxonomic sequence by families and subfamilies the grouping in the text is in such categories as: "butterflies of the home garden," "butterflies of sunshine and wild flowers," "migrants," "butterflies of the dusk," "locals and brooders," etc. In the plates the arrangement follows such categories as: "Lycaenids and Riodinids" [only a small part of each], "assorted rarities," "highly valued Brassolids," "common and well-known species," "the *Morpho* and some *Eurema* variants," etc. These unconventional arrangements have the effect of calling to one's attention the features of butterfly life in which the author is chiefly interested, and of which he is an enthusiastic proselyte. This is good. However, they make the book very difficult to use for anybody wishing to look up something about a known species, or to identify as unknown specimen. In the one case he must cruise through the checklist, since there is no index. In the other case he must leaf through the plates, often through most of them, since a species may be illustrated nearly anywhere, and its near relatives may be on one or more distant plates. In trying a test identification of an erycinid I had to keep a finger or other bookmark in each of six different places! Another set of problems, for which the author is by no means entirely responsible, arises from the confused state of butterfly taxonomy in general in the neotropical region, where many groups have not had any broad, modern taxonomic treatment. Thus *Burema daira* form "*palmyra*" and form "*ebriola*" are tentatively placed under *Eurema elathea* in the text, are given as definite subspecies of *elathea* in the plates, and are not mentioned in the checklist. (In fact, there is conclusive evidence that *E. elathea* and *E. daira* are completely distinct species.)

The author states that his main purpose has been "to interest the very young of Trinidad in at least this one particular field of their natural history." I am sure that his book will accomplish this abundantly, once the very young and other readers become accustomed and hardened to the peculiar arrangement, and will be of the greatest interest to butterfly enthusiasts.

Alexander B. Klots
The American Museum of Natural History

BOOK NEWS

Pests of the Coconut Palm. Food and Agriculture Organization. Copies may be ordered from Unipub, Inc., P.O. Box 433, New York, N.Y., 10016. $3.50.

This volume of 190 pages, represents one of a new series of publications that provide comprehensive information on pests and diseases of economically important plants and plant products. It deals with pests of the coconut palm and includes information such as: description of each pest, the type of damage caused and the control measures which have been applied.

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It will be published quarterly and is now accepting papers for the first issue scheduled for April 1971. For detailed information please write to:

Professor A. P. Gupta
Department of Entomology and Economic Zoology
Rutgers University New Brunswick, New Jersey 08903

Revision of the Ant-Lion Tribe Brachynemurini of North America (Neuroptera: Myrmeleontidae). Volume 55. Lionel A. Stange, University of California Publications in Entomology, University of California Press, Berkeley and Los Angeles. 1970. 192 pp. $5.50.

The present study brings together all published information on the tribe for North America and provides new data on generic limits. An evaluation of variation and species limits is made, based on a study collection of about 8,200 specimens. During this investigation nearly all types of known species and their synonyms were studied, resulting in considerable new synonymy and a few new name changes. Eleven new species and two new genera are proposed and keys are furnished for the identification of genera, species groups, and species. Coincident studies of distribution patterns and evolutionary trends were undertaken. Also, biological features of the tribe were investigated and new information on adult behavior and food requirements as well as on larval behavior and taxonomy is presented.

Taxonomy and Biology of the Lacewing Genus *Meleoma* (Neuroptera: Chrysopidae). Volume 58. Catherine A. Tauber, University of California Publications in Entomology, University of California Press, Berkeley and Los Angeles. 1969. 94 pp. $3.50.

Meleoma has been reported only from the New World. Prior to this study there were thirteen described entities in this group. In this revision, four of these are designated as synonyms, five species are reassigned from *Chrysopa*, and seven new species are described. The object of this work is to provide taxonomic descriptions and keys for species identification and to consider species relationships on the basis of morphological, biological, and distributional data. It includes a comparison of larval and adult taxonomy, a discussion of morphological variability vis-á-vis geographic distribution, and a presentation of some life histories and adult behavior.

Carab The Trap-Door Spider. Alice L. Hopf, illustrated by Keyo Komoda. G. P. Putnam's Sons, New York. 1970. 62 pp. $2.68.

This is a Beginning to Read book and is written with a controlled vocabulary for words that children are taught in the first grade.

Biosystematics of the Arizona, California and Oregon species of the seed beetle (Coleoptera: Bruchidae). Clarence D. Johnson. Oct. 12, 1970. University of California Publications in Entomology, 59. University of California Press. $5.50.

The author states that the primary purposes of this monograph are to redefine named species, describe new species, and to establish host plant preferences. These host plant preferences are used in classifying species in the genus and when coupled with morphological relationships are the basis for establishing a natural arrangement of species in the genus. Included in the study are species that fit Bridwell's definition of the genus Acanthoscelides (Schilsky).

Extensive collections of seeds were made in order to determine bruchid host plants and for host-specificity as another character in defining species. It was found that some of the Arizona, California and Oregon species are widely distributed in the western United States.

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A GLOSSARY OF ENTOMOLOGY, by J. R. de la Torre-Bueno (1937) with Supplement A (1962) by George S. Tulloch. This was a revision of Explanation of Terms Used in Entomology, by John B. Smith (1906)

CHECK-LIST OF THE HEMIPTERA (excepting the Aphididae, Aleurodidae and Coccidae) of America, North of Mexico, by Edward P. Van Duzee

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Melanism in *Phigalia titea* (Cramer) (Lepidoptera: Geometridae)

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Received for Publication February 6, 1971

Abstract: Data are presented on the occurrence of the typical and melanic forms of *P. titea* (Cramer) in Leverett, Massachusetts from 1968–1970. Leverett is located in a rural area, where lichens abound on trees which are not noticeably darkened by soot. Melanics comprised 20.4% of the sampled *P. titea* population (491 individuals). Melanic percentages varied little from year to year, and from week to week within each year. However, melanic moths were taken most frequently during the first hour of activity in the evening. In 1969 and 1970, *P. titea* of both forms were color-marked as they rested at lights. Total recapture percentages of the typical and melanic forms were not significantly different. The implications of these results are discussed with reference to the widely-accepted explanation of industrial melanism in England.

The spread of melanism among many moths of Europe and North America is providing an unprecedented opportunity for studying evolution in action. Since the mid-1800's in England and Europe, and more recently in North America, many geometrid and noctuid species have exhibited a dramatic increase in the occurrence of melanic forms. From the extensive studies of Kettlewell and his associates, particularly on *Biston betularia* (L.) (Geometridae) in England, the folowing major findings have emerged: 1. melanism is usually controlled by a single gene, the allele for black ordinarily being dominant to that for pale or typical coloration (Kettlewell, 1959); 2. melanic individuals appear to be more viable than typicals (Ford, 1937, 1964; Kettlewell, 1958a), and may exhibit other behavioral and physiological differences—e.g. in larval habits (Kettlewell, 1958a, 1961), courtship and mating (Kettlewell, 1957), and background selections (Kettlewell, 1955a); 3. melanic forms have increased in relative abundance in recent times, particularly in industrial areas (Kettlewell, 1958b); 4. melanic individuals are at a selective advantage in industrial areas, and at a selective disadvantage in rural areas, when compared with typical individuals; and differential predation by birds on the two forms contributes significantly to the selective advantage or disadvantage observed (Kettlewell, 1955b, 1956).

A general explanation for industrial melanism, emphasizing the cryptic advantage of melanics in industrial areas (Kettlewell, 1958a), has now gained wide acceptance. In this view, melanics are favored wherever air pollutants act to darken tree trunks through the killing of epiphytic lichens and the deposition of soot. Ample experimental data support this explanation in the case of *B. betularia* (for an extended review of this topic, see Ford, 1964).

There are, however, a number of findings which suggest that an explanation based on cryptic advantage may not suffice for all instances of increased melanism. Thus, for example, while most cases of recent melanism involve bark-like cryptic insects, at least one warningly-colored beetle, *Adalia bipunctata* L., is displaying an increase in melanic frequencies in industrial areas (Creed, 1966). Another problem is posed by the extent of melanism in ostensibly rural areas (i.e. where the trees are not devoid of lichens, and are not noticeably darkened by soot). The present study area in Massachusetts is an example. Here melanic frequencies are high in several geometrids, and these melanics, like their typical counterparts, prefer light backgrounds (Sargent, 1968, 1969)—a preference which would seem to put them at a considerable cryptic disadvantage. A further difficulty is posed by the recent finding that a steep cline exists in the melanic frequencies of *Gonodontis bidentata* Clerck (Geometridae) across the city of Liverpool (Bishop and Harper, 1970).

These last few studies suggest that the incidence of melanism in some cases may be related to effects of industrialization other than observable environmental darkening. Possible pollution effects on the insects, perhaps acting on the larvae through chemical contamination of the vegetation, would seem to warrant further investigation in this regard. It may be that the superior viability of melanics, stressed some years ago by Ford (1937, 1940), has been generally underestimated in recent discussions regarding the selective advantage of melanism. Older ideas attributing melanic success in industrial areas to relaxed selection pressure from predators might also bear some re-examination in light of these recent findings.

The relatively recent rise and spread of melanism among North American moths (Owen, 1961, 1962) may provide opportunities for study which are no longer available in England and Europe. Thus far, however, few studies have been carried out. Klots (1964, 1966, 1968a,b) has described increasing melanism among noctuids in Connecticut, and has conducted some breeding studies on the species involved. Kettlewell (1965) has provided a genetic analysis of crosses involving *Biston betularia* and the North American *B. cognataria* (Guenée). Sargent (1966, 1968, 1969), on the basis of experimental studies of background selections, has suggested that some North American melanics may not yet have evolved appropriate background preferences, as *B. betularia* in England appears to have done (Kettlewell, 1955a).

There is need for carefully acquired data on melanism in North America, and the present study is an attempt to gather such data over a period of years in an area where increasing industrialization, and consequent increasing environmental pollution, seem likely. It is hoped that this study will serve to stimulate others to obtain similar data in their areas; provide accurate data for later comparative purposes; and increase our knowledge and understanding of the entire phenomenon of industrial melanism.

METHODS

The present report summarizes data obtained on wild-caught Half-wing Geometers, *Phigalia titea* (Cramer), in Leverett, Massachusetts during the springs of 1968, 1969, and 1970. Leverett is located some 75 air-miles west of Boston, 25 air-miles north of Springfield, and 37 air-miles east of Pittsfield. The study area shows little visible evidence of industrialization—lichens abound on trees which are not noticeably darkened by soot. Leverett apparently receives little air-borne pollution from the west (the direction of the prevailing wind), as Albany, New York (66 air-miles away) is the closest large industrial center in that direction.

The melanic form of *P. titea*, f. *deplorans*, was described by Franclemont (1938), and its historical occurrence in North America has been discussed by Owen (1962). All *P. titea* obtained were easily assigned to either the typical or melanic morph, as no intergrades between the two were noted in the study area. (Figures of both morphs may be found in Remington (1958)).

The moths were collected at four 150 watt Westinghouse outdoor spotlights. In 1969 and 1970, an additional 15 watt black light fluorescent tube at my home was used. Only males were obtained, as females of *P. titea* have rudimentary wings and are not taken at lights. Most of the moths were either used in background selection experiments and subsequently sacrificed (1968), or marked as part of a mark/recapture study (1969, 1970). In the latter case, the lights were usually checked at half-hour intervals, and newly arrived moths were color-marked at each check.

In the mark/recapture study, moths alighting near the lights were marked as they rested with a small spot of Flo-Paque paint, applied with a fine brush, on one of their forewings. Marking was carried out on all but nights of heavy rain, when many moths were washed into puddles under the lights. A different color was used each night during the study in both years. The marked moths were then sought at the lights on subsequent nights, and were collected upon their return. Some of these recaptured moths were then marked and released again in order to see whether they might return, but no moths were recaptured a second time.

These procedures differ in two ways from those used in prior mark/recapture experiments (e.g. Kettlewell, 1955b, 1956; Kettlewell and Berry, 1969). First, individuals were marked on the upper surface of the wings, rather than the underside, eliminating any need to anesthetize or handle the moths, but also perhaps introducing some effects on visual predation. Second, no laboratory-reared individuals were released into the study area, eliminating any unusual

Table 1. Total numbers of typical and melanic *P. titea* taken over three years in Leverett, Mass.

Forms	Years 1968	1969	1970	Totals
Typical	125	135	131	391
Melanic	44	26	30	100
% Melanic	26.0	16.1	18.6	20.4

predation effects which might result from artificially dense populations of prey, but also placing definite limits on sample size.

The data obtained in these studies were amenable to analysis by chi-square 2 × 2 tests, and all values of chi-square presented with the results were obtained in this manner.

ANALYSIS OF CAPTURES

A summary of the occurrence of typical and melanic *P. titea* over three years is presented in Table 1. The ratio of typical/melanic individuals varied little from year to year, with melanics averaging 20.4% of the population. Melanic numbers, relative to typicals, were higher in 1968 than in 1969 (chi-square 4.82, P less than 0.05), but no other differences between years were found (1968/1970, chi-square 2.60, P greater than 0.10; 1969/1970, chi-square 0.35, P greater than 0.50). Thus, no trend of increasing or decreasing melanism was discernible over this period.

Table 2. Numbers of typical and melanic *P. titea* taken by weeks over three years in Leverett, Mass.

Weeks	Typical/Melanic (% Melanic) 1968	1969	1970	Totals
March 25–31	66/8 (10.8)	—	—	66/8 (10.8)
April 1–7	37/25 (40.3)	48/9 (15.8)	—	85/34 (28.6)
April 8–14	14/2 (12.5)	74/14 (15.9)	74/17 (18.7)	162/33 (16.9)
April 15–21	8/7 (46.7)	13/3 (18.7)	23/4 (14.8)	44/14 (24.1)
April 22–28	0/2 (100.0)	—	31/8 (20.5)	31/10 (24.4)
April 29–May 5	—	—	3/1 (25.0)	3/1 (25.0)

Table 3. Numbers of typical and melanic *P. titea* taken by hours over two years in Leverett, Mass.

Hours[1]	Typical/Melanic (% Melanic) 1969	1970	Totals
7:00–8:00 PM	13/6 (31.6)	39/13 (25.0)	52/19 (26.8)
8:00–9:00 PM	48/10 (17.2)	40/5 (11.1)	88/15 (14.6)
9:00–10:00 PM	32/5 (13.5)	25/4 (13.8)	57/9 (13.6)
10:00–11:00 PM	21/4 (16.0)	10/2 (16.7)	31/6 (16.2)
11:00–12:00 PM	7/0 (0.0)	0/1 (100.0)	7/1 (12.5)

[1] Eastern Standard Time.

The numbers of typical and melanic individuals taken each week of the season for three years are given in Table 2. Although the weekly typical/melanic ratios were variable, there were no trends indicating a relative increase or decrease of either form with the advance of the season.

Table 3 presents the ratios of typical/melanic individuals taken each hour of the evening over two years. In both years, relatively more melanics were taken during the first hour of activity than during all later hours, and this difference was significant for the combined data of the two years (chi-square 5.55, P less than 0.02).

MARK/RECAPTURE EXPERIMENT

The numbers of *P. titea* marked and recaptured during two years are presented in Table 4. Over both years, the numbers of typical and melanic moths recaptured, relative to the numbers of each that were marked, were not significantly different (chi-square 0.42, P greater than 0.50).

Most of the recaptures were made on the first night following the night of

Table 4. Results of mark/recapture experiments with *P. titea* over two years in Leverett, Mass.

	Number Marked			Number Recaptured			Percent Recaptured		
Forms	1969	1970	Total	1969	1970	Total	1969	1970	Total
Typical	131	107	238	11	7	18	8.4	6.5	7.6
Melanic	23	24	47	4	1	5	17.4	4.2	10.6

marking (11 typicals, 61%; 3 melanics, 60%). Other recaptures occurred on the second (1 typical, 1 melanic), third (5 typicals), and fifth (1 typical, 1 melanic) nights following marking.

DISCUSSION

The extent of melanism in *P. titea* recorded here (20.4%) is more than double any reported by Owen (1962) for this species. This difference may reflect a real difference between the present study area and those Owen sampled, or may be due to a general increase in melanism since the time of Owen's surveys. Unfortunately, data permitting distinction between these alternatives are not available. Such a situation emphasizes the desirability of obtaining data on melanism for many years in a given locality.

If melanic *P. titea* were at a cryptic disadvantage to typicals in the present rural study area, one might expect melanic percentages to decrease with seasonal advance (assuming no differences between typicals and melanics in terms of emergence time or longevity). However, data over three years gave no evidence of such a decrease, suggesting that whatever predation occurs is not highly selective between the typical and melanic moths. These same data tend to dispel the idea that melanics eclose early, before the return of many insectivorous birds, in species which are on the wing in the early spring. If this were true, one would expect to record higher percentages of melanics earlier in the season, and the data show no such trend.

Results of this study do indicate that melanic *P. titea* are more commonly taken at lights very early in the evening than at any later time. While the significance of this early activity on the part of melanics is obscure at present, the phenomenon warrants further investigation. Certainly it now seems advisable to record the time of night whenever sampling for melanics is carried out.

The present mark/recapture experiment revealed no significant difference between the recapture percentages of typical and melanic moths. This result differs from that obtained by Kettlewell (1956) in a mark/release/recapture experiment involving typical and melanic *Biston betularia* in a rural area in England, where typicals were recaptured at twice the level of melanics.

Experiments of this sort are rather crude, and with small sample sizes, one expects negative results unless one morph is at a considerable selective advantage over the other. Typicals were apparently at such an advantage in the *B. betularia* situation studied by Kettlewell, but no evidence for any such advantage was obtained with *P. titea*. A larger sample of marked *P. titea* should be obtained, but at present it appears that any selective advantage of either adult morph must be rather small. This may indicate that differential selection operates most strongly on some earlier life cycle stage, and that the present sample of marked adults was already a product of such differential selection.

It is interesting to note that despite some differences in procedure, the recapture patterns and percentages obtained in the *B. betularia* and *P. titea* studies were comparable. No anomalous recapture patterns, like the first-night deficit described by Kettlewell et al (1969) in some populations of *Amathes glareosa* (Esper) (Noctuidae), were noted.

The over-all results of the present study suggest that the factors responsible for melanism in *P. titea* may be different than those described for *B. betularia* in England. The substantial melanism recorded here in a rural area is somewhat unusual in itself, although Owen (1962) noted that melanic *P. titea* were not first reported from near industrial centers. Melanic *P. titea* should be at a cryptic disadvantage in an area where backgrounds have not been noticeably darkened by pollution. This seems especially true in view of the previously demonstrated preference of these melanics for light backgrounds (Sargent, 1969). However, in spite of what should be a cryptic disadvantage, melanics now comprise a substantial proportion of the *P. titea* population, and must then have some advantage, perhaps a physiological superiority, over typicals. Effects of industrialization, other than observable environmental darkening, may be involved in this situation. Perhaps, for example, the larvae of melanics are better able to tolerate certain chemicals that are being introduced into the environment via air pollution. It may also be that industrialization is reducing selection pressures on cryptic moths by destroying the essential habitat and food supplies of many predators.

Our understanding of the phenomenon of industrial melanism is far from complete. Opportunities for its study are still widely available, especially in North America and I hope these opportunities will not be lost.

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Cerceris from Florida (Hymenoptera: Sphecidae).[1]

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Abstract: A new species of Sphecoid wasp, *Cerceris* **rozeni**, is described from Florida. Structures of the male and female are illustrated.

Cerceris **rozeni,** n. sp.

FEMALE: Length 10 mm. Background color black, markings ferruginous; deeply and closely pitted; pubescence very short and inconspicuous.

Head slightly wider than the thorax; black except the clypeus, large frontal eye patch, frons, mandibles, and much of the antennae, all of which are ferruginous; no clypeal process on the surface of the medial lobe; clypeal margin with a broad medial carina-like extension with a small denticle closely adhering to each side of the extension; mandibles with two low carina-like denticles; antennae normal in form.

Thorax black except for a broad band on the pronotum, the scutellum, the metanotum, and the tegulae, all of which are ferruginous; tegulae low and smooth; mesosternal tubercle absent; enclosure strongly rugose and with the usual medial groove; legs ferruginous; wings light amber with a large pale stigma.

Abdomen black except terga 1 and 2, a narrow line on tergum 3, sternum 1, and much of sternum 2, all of which are ferruginous; pygidium as illustrated, fig. 2.

MALE: Length 8 mm. Black with ferruginous markings; deeply and closely pitted; pubescence very short.

Head slightly wider than the thorax; black except for the entire face below the antennal scrobes, the mandibles, and most of the antennae except for several medial segments, all of which are ferruginous; extension of the medial clypeal lobe margin very broad with three indistinct denticles.

Thorax black except for a broad band on the pronotum, the scutellum, the metanotum, and the tegulae, all of which are ferruginous, and a slightly browning area on each side of the propodeum; tegulae low and smooth; enclosure rugose; mesosternal tubercle absent; legs ferruginous; wings light amber with a pale stigma.

Abdomen black except terga 1 and 2, a narrow band on tergum 3, sternum 1 and most of sternum 2, all of which are ferruginous; pygidium as illustrated, fig. 4.

C. **rozeni** Scullen closely resembles *C. blakei* Cresson, which is also found in Florida. These species are similar in size and color. They may be distinguished by the prominent clypeal process, the small but distinct mesosternal tubercle, and the dark stigma on the female of *C. blakei* Cresson. The extension on the border of the medial clypeal lobe of the male *C.* **rozeni** Scullen is much broader

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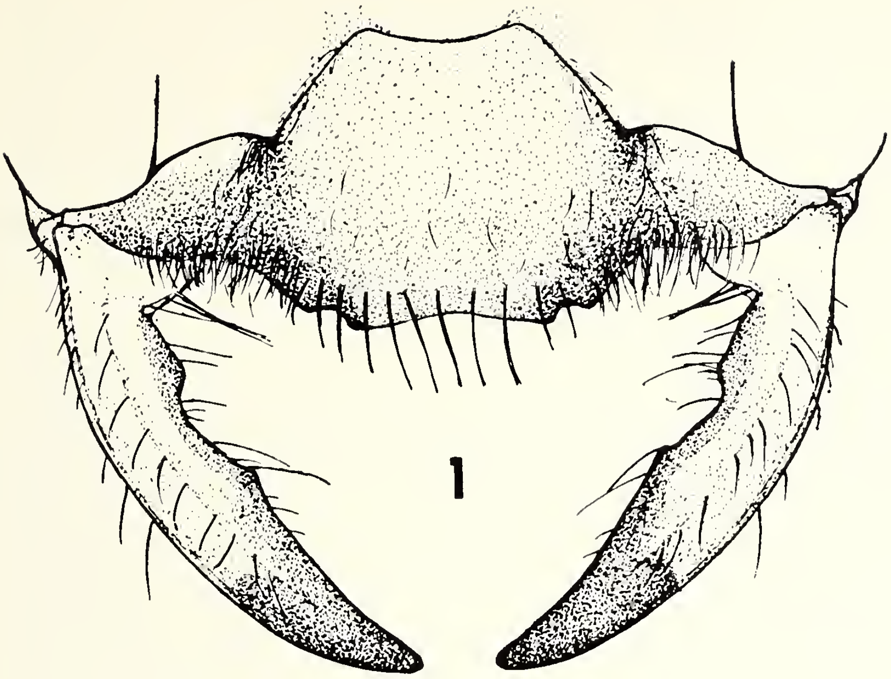
[1] The author's studies relating to the Tribe Cercerini are financed by National Science Foundation grants and General Research grants from Oregon State University.



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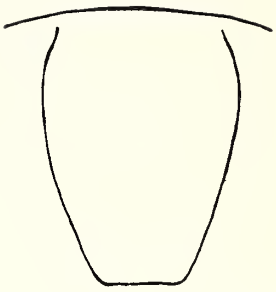

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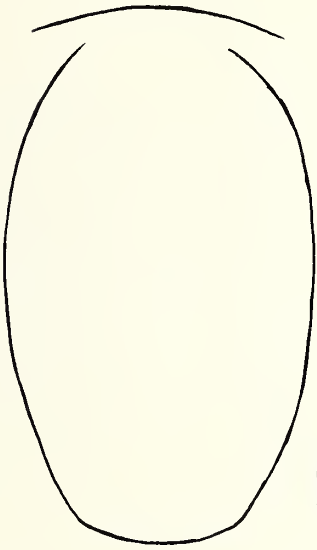

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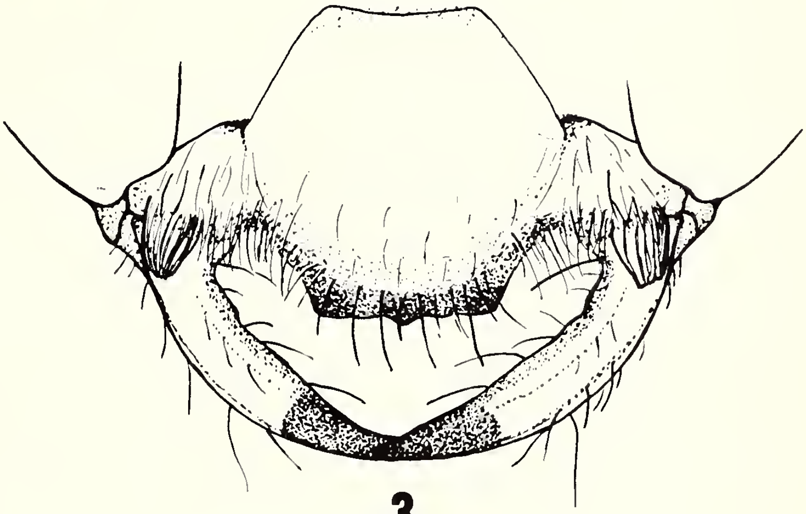

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Fig. 1. Lower face of female, *Cerceris* **rozeni** Scullen.
Fig. 2. Pygidium of female.
Fig. 3. Lower face of male.
Fig. 4. Pygidium of male.

than that of *C. blakei* Cresson. Details of the color pattern will also be of help in separating the species.

TYPES: The type female of *C.* **rozeni** Scullen was taken at Archbold Biological Station, Highlands Co., Florida, April 14, 1963 (J. G. and B. L. Rozen). It is at the American Museum of Natural History, New York. The allotype male of *C.* **rozeni** Scullen is at the U. S. National Museum also taken at the Archbold Biological Station, Highlands Co., Florida, April 10–26, 1969 (K. V. Krombein). Paratypes are as follows: ♀, Archbold Biological Station, Highlands Co., Fla., April 14, 1963 (J. G. and B. L. Roaen); 4♂♂, Archbold Biological Station, Highlands Co., Fla., April 10–26, 1969 (K. V. Krombein).

DISTRIBUTION: Known only from the type locality, Archbold Biological Station, Highlands Co., Fla.

PREY RECORD: None.

PLANT RECORD: None.

Factors Affecting the Susceptibility of the Beetle *Tribolium confusum* to Infection by *Hymenolepis diminuta*

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Received for Publication April 21, 1971

Abstract: The number of cysticercoids of the tapeworm *Hymenolepis diminuta* established in the insect intermediate host, *Tribolium confusum*, were found to be significantly influenced by the temperature at which the beetles were maintained, the number of days starvation of the beetles before infection, the period of exposure to the parasite eggs, and the age of the beetles.

The higher the temperature in the range 20°–35°C., the longer the period of starvation up to 8 days, the older the beetles up to 15 days, and double the period of exposure to the parasite eggs, all resulted in an increase in the average parasite burden per beetle.

In heavily parasitised hosts the effect of crowding resulted in smaller cysticercoids. Infectivity was not impaired.

INTRODUCTION

The adult tapeworm, *Hymenolepis diminuta* (Rudolphi, 1819), Blanchard, 1849 has been used extensively in experimental studies involving various aspects of the host-parasite relationship. In contrast, studies on the relationship between the larval stage of the tapeworm, and the intermediate host(s) are rare (Voge and Turner, 1956, Voge and Heyneman, 1957, 1958; MacDonald and Wilson, 1964; Kelly et al., 1967; Soltice et al., 1971).

The results regarding the factors affecting the infectivity of beetles to the larval stages of *H. diminuta*, are conflicting. Thus, while Kelly et al. (1967) reported that the age and the sex, but not starvation, of the beetle *Tribolium confusum* affected infectivity, Soltice et al. (1971) found that, in the two *Tribolium* species they were using *T. confusum* and *T. castaneum*, infection of the beetles was only influenced by temperature, and not by host species, host sex, or the number of eggs ingested. The present results confirm and delimit the effect of temperature upon beetle infectivity show that the number of eggs ingested does affect the level of beetle infection, and also show that the age of the beetle and starvation have significant effects upon the number of mature cysticercoids that are established per beetle.

MATERIALS AND METHODS

The initial strains of *Hymenolepis diminuta* and *Tribolium confusum* were obtained in 1965 from the Wellcome Laboratories for Experimental Parasitology (Professor C. A. Hopkins), University of Glasgow, Scotland.

The stock cultures of beetles were maintained at 26°C. on wholewheat flour. The adult worms were maintained in Wistar strain rats.

New York Entomological Society, LXXIX: 133–138. September, 1971.

Unless stated otherwise, beetles, of varying age and sex were removed from several stock cultures, and pooled. From these pooled samples, groups of beetles were taken for individual experiments as required. The groups of beetles were starved for 4 days (96 hours), at 26°C. before exposure to the hymenolepid eggs.

Mature eggs from the gravid segments of *Hymenolepis diminuta* were concentrated in a balanced salt solution (Read et al., 1963). Two or three drops of this concentrate were added to a very small quantity of wholewheat flour on a filter paper in the bottom of a 2″ petri dish. The eggs and flour were thoroughly mixed prior to the introduction of the starved beetles. About 50 beetles were placed in each petri dish and allowed to feed for 24 hours at 26°C. before being transferred to culture jars filled with wholewheat flour to a depth of 1 inch. At this temperature development of the eggs to mature infective cysticercoids is completed in 13 days (Voge and Turner, 1956). Beetles were dissected for recovery of the cysticercoids on the 15th day postinfection, day 1 being the egg feeding period.

The results were evaluated statistically by analysis of variance (Snedecor and Cochran, 1967). Duncan's Multiple-Range Test (Steel & Torrie, 1960) was used to compare each group mean with every other within each analysis. Where shown in the tables, the results were calculated at the 95% level of significance. Included in the tables are the standard errors of the means.

RESULTS

Prior to determining the effect of age, starvation and temperature on the number of cysticercoids established per beetle, 5 groups of 50 beetles were infected and maintained as described above in Materials and Methods. From each group 20 beetles were picked at random on the 15th day postinfection, dissected, and the number of cysticercoids present in each beetle determined. The average number of cysticercoids per beetle in the five separate groups varied from 15.7 ± 2.2 to 20.0 ± 2.7. The overall mean was 17.5 ± 2.4, which may be considered as the standard value against which the following results may be compared.

1. AGE OF BEETLE: Young beetles, 24–48 hours old, were obtained from stock cultures, from which all adult beetles had been removed 24 hours previously. After pooling, the young beetles were divided into three groups. Group 1 was immediately starved for the mandatory 4 days, Group 2 was starved when the beetles were 6–7 days old, and Group 3 when the beetles were 11–12 days old. The three groups of beetles were thus 5–6, 10–11, and 15–16 days old respectively when allowed to feed on the hymenolepid eggs. Thirty beetles from each group were examined on the 15th day postinfection. All beetles were maintained at 26°C. throughout the experiment.

The results in Table 1 show that there was a statistically significant ($P < 0.05$) increase in the average number of cysticercoids recovered per beetle as the age of the beetles increased.

Table 1. Effect of age of beetle on the number of cysticercoids established per beetle.

Age of beetle (days)	5–6	10–11	15–16
Number of cysticercoids recovered per beetle ± S.E.	14.4 ± 1.7	16.4 ± 1.2	19.9 ± 1.7
Statistical significance*	—	—	
		—	—

* Any two means not underscored by the same line are significantly different at the 95% level of significance.

2. starvation of beetle: Beetles of random age were collected and divided into 8 groups as described in Materials and Methods. Each group was starved for a different length of time before the beetles were allowed to feed on the eggs. Thirty beetles from each group were examined on the 15th day postinfection. All beetles were maintained at 26°C. throughout the experiment.

There was a highly significant ($P < 0.001$) increase in the average number of cysticercoids established per beetle with an increase in the number of days that the beetles had been starved prior to infection (see Table 2).

3. temperature: Prior to infection, 6 groups of pooled, random aged, beetles from stock cultures were acclimatised for 48 hours to the following six temperatures ± 0.5°C.: 20°, 23°, 26°, 29°, 32° and 35°C. After this period of acclimatisation all the beetle groups were maintained at their particular experimental temperature and starved for 4 days prior to exposure to hymenolepid eggs for 24 hours.

The average number of cysticercoids recovered per beetle on the 15th day postinfection for the six experimental temperatures, is shown in Table 3. Each value is the mean of 20 beetles.

Although some immature cysticercoids were noted, no cysticeroids had developed to maturity after a 26 day period at 20°C.

Table 2. Effect of starvation of beetle on the number of cysticercoids established per beetle.

Period of Starvation (days)	0	1	3	4	5	6	7	8
Number of cysticercoids recovered per beetle ± S.E.	7.7 ±1.3	8.1 ±1.5	8.5 ±1.6	10.3 ±1.4	12.7 ±1.6	13.1 ±1.6	14.4 ±1.6	14.9 ±1.5
Statistical significance*	—	—	—	—				
		—	—	—	—			
			—	—	—	—	—	
				—	—	—	—	—

* Any two means not underscored by the same line are significantly different at the 95% level of significance.

Table 3. Effect of temperature on the number of cysticercoids established per beetle.

Temperature °C	20	23	26	29	32	35
Number of cysticercoids recovered per beetle ± S.E.	**0.0 ±0.0	8.0 ±1.2	15.5 ±1.7	17.1 ±2.0	19.4 ±2.1	24.2 ±2.7
Statistical significance*					|———	———|
		|———	———	———	———|	

* Any two means not underscored by the same line are significantly different at the 95% level of significance.

** No mature cysticercoids were recovered at this temperature by 26 days postinfection.

4. LENGTH OF EXPOSURE TO HYMENOLEPID EGGS: In the above three experiments, beetles were allowed to feed on the hymenolepid eggs for 24 hours. To determine the effect of increasing this feeding period 50 beetles were starved for 7 days prior to exposure to the eggs. After 24 hours feeding, 25 of these beetles were transferred to a stock culture jar containing wholewheat flour, while the remaining 25 beetles were exposed to a second batch of hymenolepid eggs for a further 24 hours. The second beetle group was then transferred to a second culture jar containing flour. Twenty beetles from each group were examined for cysticercoids on the 15th day postinfection, day 1 being considered as the second 24 hour period in the case of the beetles exposed to the two batches of hymenolepid eggs.

There was a highly significant increase ($P < 0.01$) in the average number of cysticercoids established per beetle with an increase in the length of exposure of the beetles to the hymenolepid eggs. With 24 hours exposure the average number of cysticercoids recovered per beetle was 23.7 ± 2.2; with 48 hours exposure 34.4 ± 2.9 cysticercoids were recovered per beetle.

DISCUSSION

The results presented above show that the age of the host, the length of the period of starvation prior to feeding, the length of the egg feeding period and the temperature all had statistically significant effects on the number of cysticercoids of *H. diminuta* established per beetle. Of these 4 factors, the age of the beetles had the least influence on cysticercoid development; increasing the length of the egg feeding period had the greatest influence.

The results indicate that there is an increase in infectivity with increasing age of the beetles.

Kelly et al. (1967) found heavier infections of *H. diminuta* in older (23–24 weeks) male *Tribolium confusum* than in beetles only 4–5 weeks old but young female beetles were more heavily infected than older (23–24 weeks) female beetles. These authors also found that the level of infections declined in both male and female beetles that were 47–51 weeks old. It is unlikely, as suggested by Kelly et al. (1967), that this decline was directly due to age immunity, as the beetles are sexually mature breeding adults before they are a month old. Rate of feeding may decline in old age. The increase in the number of cysticercoids recovered per beetle in the present experiments, may be a reflection of increased food intake associated with growth and sexual maturation in the beetles while they are still very young.

Similarly, the increase in the number of cysticercoids recovered per beetle due to an increase in the period of starvation prior to infection, may also be related to the level of food intake by the beetles. The moist egg-flour mixture was not as palatable to the beetles as their normal diet, and thus the degree of hunger of the animals probably regulated the amount of feeding on the egg-flour mixture. From a practical point of view 4 days starvation appeared to be the minimum period of starvation required before there was a significant increase in the number of cysticercoids recovered per beetle. The results from the fourth experiment, in which one group of beetles was allowed to feed on an egg-flour mixture for 24 hours and a second group for 48 hours, further supports the conclusion that the number of cysticercoids recovered per beetle was directly related to the amount of feeding carried out by the beetles. It is unlikely that, under the conditions tested, any chemical or mechanical factors could have significantly influenced the degree of infection of the beetles.

As an example of a mechanical factor it is pertinent to point out that Kelly et al. (1967) fed their beetles directly on tapeworm segments. Disregarding sex, the average number of cysticercoids recovered per beetle after 5–8 days starvation and up to 24 weeks old was only 6.9. In contrast, in our experiments in which the eggs were fed directly to the beetles after 5–8 days starvation (see Table 2), the average number of cysticercoids recovered per beetle was 13.8—a 100% increase. This difference may be simply because the beetles had to eat worm tissue before they even reached the eggs, and therefore, of course, ingested less eggs over the 24 hour feeding period.

Beetles which were heavily infected contained cysticercoids which showed the effects of crowding. The cysticercoids were smaller in size and their cercomeres were shorter than those of cysticercoids from light infections. No impairment in the infectivity of cysticercoids from heavy infections was noted when they were fed to the final host. Similar results due to crowding were recorded by Voge and Turner (1956) and Voge and Heyneman (1957). There was increased mortality among the heavily parasitised beetles, which confirms a similar observation of MacDonald and Wilson (1964).

Both Voge and Turner (1956) and Soltice et al. (1971) have shown that temperature significantly affects cysticercoid development and establishment. Voge and Turner (1956) reported that the most favourable temperature for raising cysticercoids of *H. diminuta* was 30°C. At this temperature development to maturity occurred in 8 days, as compared with 23 days at 20°C. In the present experiments no mature cysticercoids were recovered from the beetles after 26 days at 20°C.; there was a steady increase in the number of mature cysticercoids recovered per beetle over the temperature range 23–35°C. Soltice et al. (1971) suggested that the effect of temperature on the intensity of infection was related to the efficiency of the enzyme-catalyzed reactions of the host and parasite which were concerned with the digestion of the egg layers and the penetration and development of the onchosphere.

Metabolic rates of poikilothermic animals are greatly increased with an increase in temperature. The increase in the number of mature cysticercoids recovered per beetle with increased temperature, may therefore be explained in terms of increased metabolic rates leading to increased food intake and thus a heavier infestation of the beetles.

It should also be noted that, contrary to the procedure used by Voge and Turner (1956) in their experiments on the effect of temperature, the beetles were acclimatised to the experimental temperatures before starvation and infection. Thus, temperature affected both infectivity of the beetles and development of the cysticercoids.

In conclusion, the four significant factors affecting the number of mature cysticercoids established per beetle may all be explained in terms of food intake by the beetles.

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The *Brueelia* (Mallophaga: Ischnocera) of the Picidae (Aves: Piciformes)

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Abstract: Three species of *Brueelia* from the Picidae are recognized and discussed; two of which are newly described: *B.* **goertae** from *Mesopicos goertae*; and *B.* **guatemalensis** from *Phloeoceastes guatemalensis. Nirmus superciliosus* Nitzsch, is placed in *Picicola* not *Brueelia,* in which it was included by Hopkins and Clay (1952:62). Specimens from 8 genera and 15 species of Picidae were examined. A key is given and all species are illustrated.

Key to the species of *Brueelia* from the Picidae.

1. Marginal temporal setate 3 and 4 elongate; head wider than long .... **guatemalensis**
   Marginal temporal seta 3 elongate, 4 short; head longer than wide 2
2. Anterior depression of head deeper than wide; head shape diagnostic .... **goertae**
   Anterior depression of head wider than deep; head shape diagnostic, forehead rounded in outline .... *straminea*

Brueelia Keler, 1936

Brüelia Keler, 1936, Arb. morph.-tax. Ent. Berlin-Dahiem, **3:** 257. Type-species: *B. rossittensis* Keler.

Corvonirmus Eichler, 1944, Stettin, ent. Ztg. **105:** 81. Type-species *Nirmus uncinosus* "Nitzsch in Burmeister."

Meropsiella Conci, 1941, Boll. Soc. ent. Ital., **73:** 104. Type-species: *Nirmus apiastri* Denny.

Painjunirmus Ansari, 1947, Proc. nat. Inst. Sci. India, **13:** 285. Type-species: *P. pengya* Ansari.

Traihoriella Ansari, 1947, l.c.: 290. Type-species: *T. punjabensis* Ansari.

Guimaraesiella Eichler, 1949, Boll. Soc. ent. Ital., **79:** 11. Type-species: *Docophorus subalbicans* Piaget.

Xobugirado Eichler, 1949, Boll. Soc. ent. Ital., **79:** 13. Type-species: *Nirmus submarginellus* "Nitzsch sensu Piaget."

Brueelia is known from the Passeriformes, Piciformes and Trogoniformes. It includes a large number of species which have been split into many genera by some authors. Of the 143 species included in their checklist, Hopkins and Clay (1952:52–63) recognize only 119 as being valid. Ansari (1956, 1957),

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has revised the species from the Corvidae (Passeriformes), however there has been no comprehensive revision of the genus nor of the species found on the Picidae. The genus appears to infest all Picidae, though it is not collected as frequently as other genera known to infest this family. The species from the Picidae are, in general, only slightly sclerotized and are subject to considerable distortion during mounting.

Ansari (1956:23) recognized two major groups among those species known from the Corvidae. The first he characterized as being feebly sclerotized and with sparse abdominal chaetotaxy. To this description, I would add that the male genitalia are of the type figured for *B. straminea* (Fig. 6). In this group Ansari (1.c) included *B. deficiens* (Piaget) from *Cyanopicta cyanus cooki*, *Aphelocoma c. californica* and *Cyanocitta stelleri frontalis*; *B. zavattariornis* from *Zavattariornis stressemanni*; and *B. zohrae* from *Philostomus afer*. To the DEFICIENS GROUP I add *B. straminea* (Denny) and *B.* **goertae** described herein. The remaining species from corvids considered by Ansari are characterized as being robust and more heavily sclerotized. *Bruellia* **guatemalensis** n. sp. belongs in this second group, though it is clear from an inspection of Ansari's figures that this group is much more polymorphic than the first.

All specimens examined were mounted on slides. Descriptions, illustrations and measurements are based on specimens macerated in hydroxide, cleared and mounted in Canada Balsam. The host nomenclature follows that of Peters (1946).

Brueelia ***guatemalensis*** n. sp.

(Figs. 1, 2, 7)

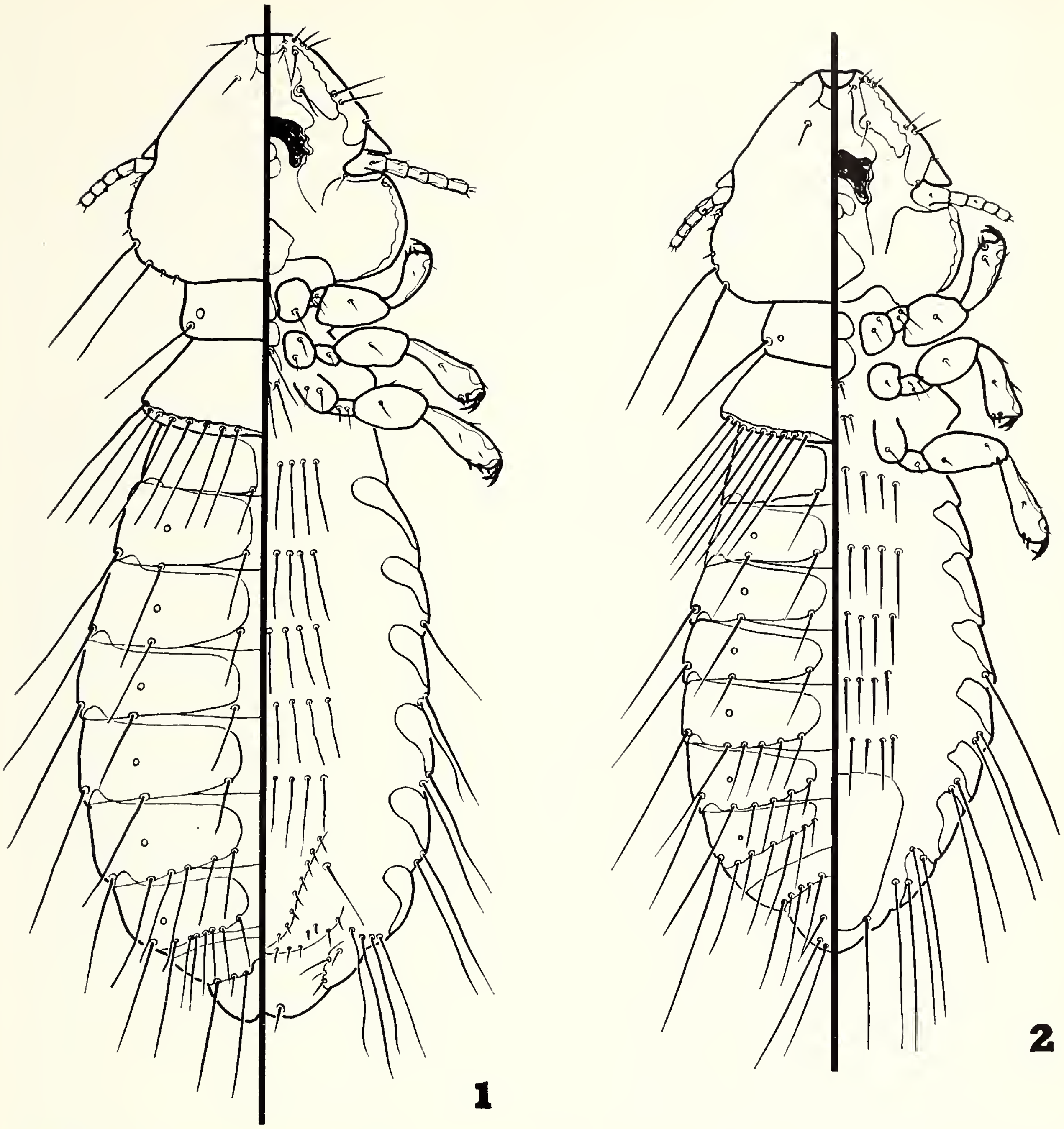
Type host: *Phloeoceastes guatemalensis* (Hartlaub)

This species is readily distinguished from all others known from the Picidae by the 2 pairs of elongate marginal temporal setae.

Head wider than long, median anterior hyaline depression wider than deep. Dorsal anterior plate of forehead poorly defined. Marginal temporal setae 3 and 4 elongate, ocular setae and marginal temporal setae 1, 2, 5 and 6 short and inconspicuous. Dorsal posterior margin of pterothorax with 8 elongate and 1 short seta each side. Tergites II–VIII divided, IX entire and notched posteriorly. Pleural thickenings conspicuous. Pleural setae present on segments IV–IX. Tergites III–VIII each with postspiracular setae, II–V each with a seta at the posterior median angle, VI–VII each with 4 and VIII with 5 centroposterior setae, IX with 3 long and 2 short posterior setae. Thoracic sternites poorly defined. Meso- and metasternal plates each with two pairs of setae. Abdominal sternites poorly defined, II–VI each with 4 pairs of setae.

Male genitalia (Fig. 7) with lateral margins of parameres convex and stout, mesosomal complex lacking sensilla and with stout lobes with smooth distal margins.

Dimensions (in mm.). Male, holotype: total length, 1.92; head length, 0.52; head width, 0.56; prothorax width, 0.33; pterothorax width, 0.52; abdominal width, 0.67. Female: total length, 2.21; head length, 0.55; head width, 0.59; prothorax width, 0.33; pterothorax width, 0.52; abdominal width, 0.79.



Figs. 1, 2. *Brueelia* **guatemalensis** n. sp., dorsal and ventral views of (1) female and (2) male. Drawn to the same scale.

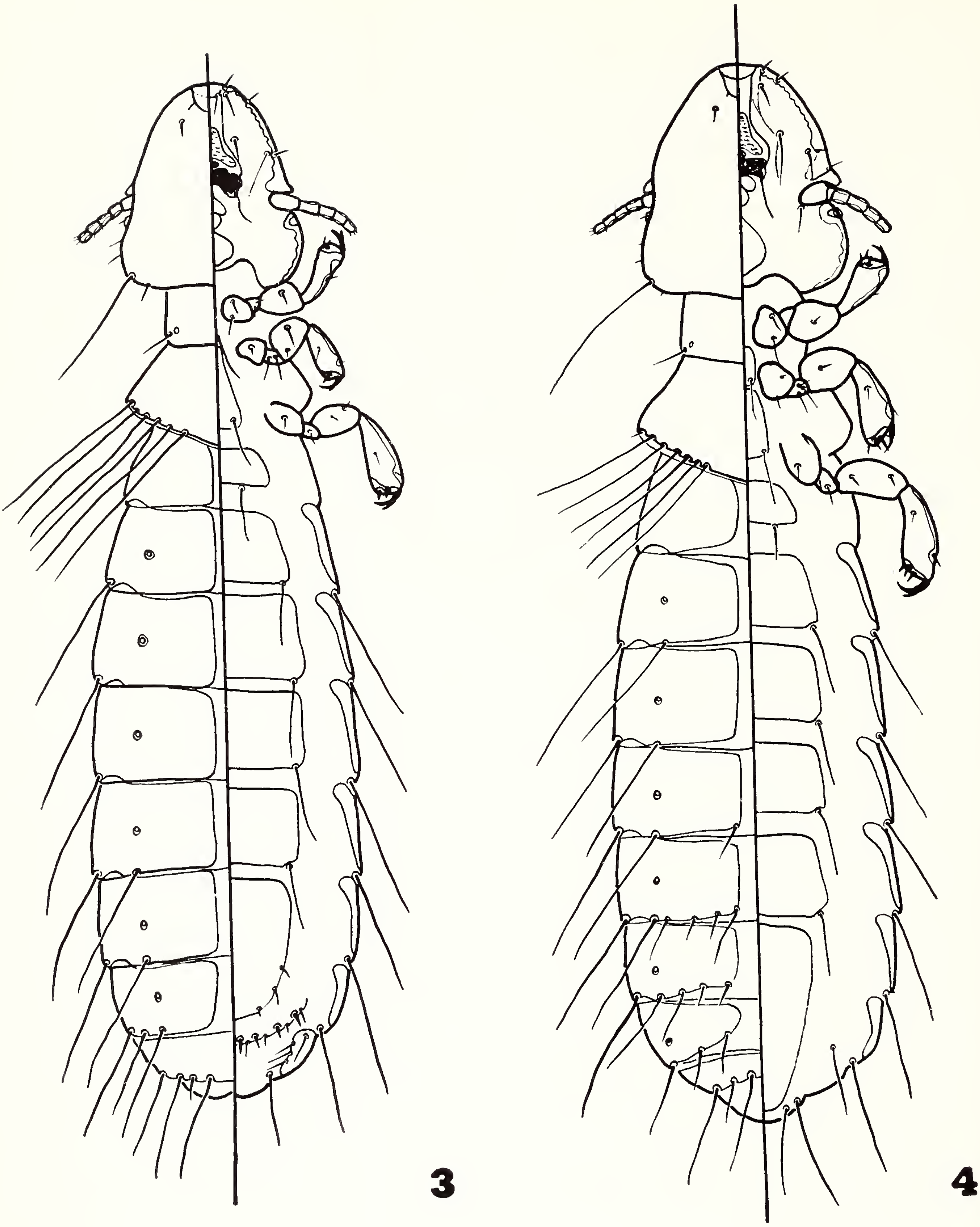
HOLOTYPE ♂ and 1 ♀ paratype from *Phloeoceastes guatemalensis* from Santa Clara, Chiriqui Prov., Panama, G. Hartmen, 15 Feb., 1956, Brit. Mus. 1956–449. Types deposited in the British Museum (Natural History).

Brueelia **goertae** n. sp.

(Figs. 5, 8)

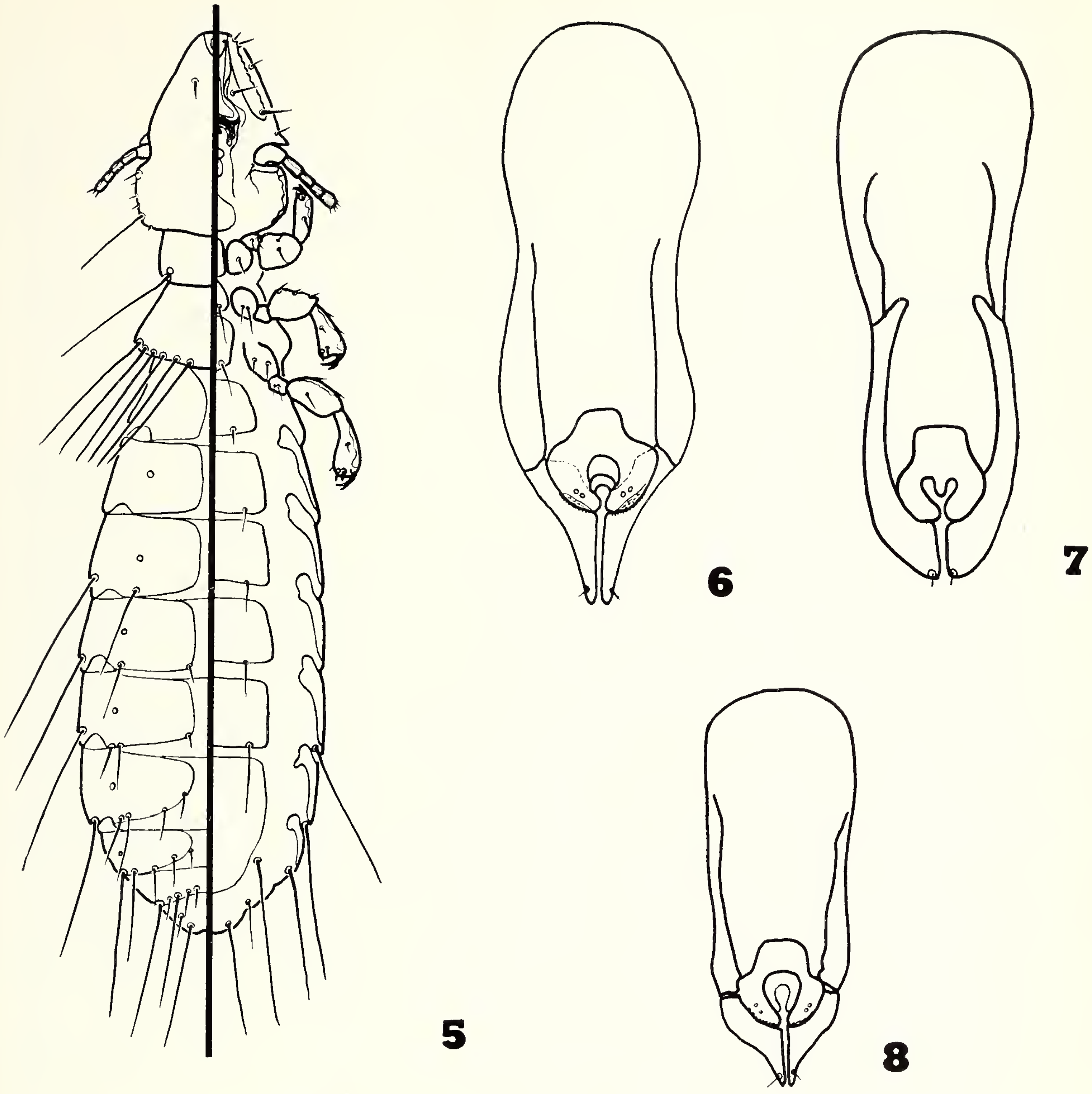
Type host: *Mesopicos goertae* (P. L. S. Müller)

This species does not closely resemble any other known from the Picidae. The slender head, elongate abdomen and sparse abdominal chaetotaxy readily distinguishes it from *B. straminea*, to which there is some similarity in the shape and form of the male genitalia.



Figs. 3, 4. *Brueelia straminea* (Denny), dorsal and ventral views of (3) female and (4) male. Drawn to the same scale.

Known only from a single male. Head longer than wide, anterior median depression of forehead deeper than wide. Marginal temporal seta 3 elongate, others short and inconspicuous. Pterothorax with 6 elongate and 1 short seta each side. Tergites II–VIII divided, IX entire, II–III lacking centroposterior setae, IV–V each with 1 pleural and 1 postspiracular seta each side, VI–VII with 2 pleural and 1 short seta adjacent to the



Figs. 5, 6, 7, 8. *Brueelia* **goertae** n. sp., dorsal and ventral views of (5) male. Male genitalia of: (6) *Brueelia straminea* (Denny); (7) *Brueelia* **guatemalensis** n. sp.; (8) *Brueelia* **goertae** n. sp.

postspiracular setae, VIII with 3 centroposterior setae on each side. Sternites darker than tergites, each with 1 pair of lateroposterior setae. Terminal segment with a shallow posterior notch.

Male genitalia (Fig. 8) with parameres concave laterally and shorter than those of *B. straminea.* Basal plate only slightly concave laterally. Mesosomal plate with 2 pairs of sensilla and an irregular distal margin.

Dimensions (in mm.). Male, holotype: total length, 1.66; head length, 0.38; head width, 0.29; prothorax width, 0.19; pterothorax width, 0.29; abdominal width, 0.44.

HOLOTYPE ♂ from *Mesopicos goertae,* Maroua, N. Cameroon, J. Mouchet, Brit. Bus., 1960–295. Type deposited in the British Museum (Natural History).

Brueelia straminea (Denny, 1842)

(Figs. 3, 4, 6)

Type host: *Dendrocopos major anglicus* (Hartert)

Nirmus stramineus Denny, 1842, Mon. Anopl. Brit.: **53**, 139, pl. 8, fig. 9. Host: *Picus major* L.

Picicola straminea (Denny); Eichler, 1942, Deut. ent. Ges. **11:** 78.

Degeeriella straminea (Denny); Seguy, 1944, Fauna de France **43:** 310, fig. 471.

Brüelia straminea (Denny); Hopkins and Clay, 1952, Check list of genera and species of Mallophaga: 61. Host: *Dendrocopos major anglicus.* (*B. sublucida* placed as a synonym.)

Degeeriella sublucida Blagoveshtchensky, 1940, Mag. Parasit. Leningrad **8:** 58, 85, fig. 15. Type host: *Dryobates major poelzami* (Bogdanov).

Brueelia fixa Zlotorzycka, 1964, Acta Parasit. Polon. **12:** 256, figs. 4e, 4f. Type host: *Dendrocopos leucotos* (Bechstein). NEW SYNONYMY.

This species (Figs. 3, 4) is distinguished from the two others known from the Picidae, by the single pair of elongate marginal temporal setae and the wide hyaline median depression of the anterior margin of the forehead.

Head longer than wide, anterior hyaline depression wider than deep. Dorsal anterior plate of forehead poorly defined by a narrow preantennal suture. Marginal temporal seta 3 elongate, others short and inconspicuous. Posterior dorsal margin of pterothorax angulate and bearing 8 elongate and 1 short seta each side. Pleural thickenings lightly sclerotized. Sternites poorly defined, 1 slender, elongate seta each posterior angle. Pleural setae on segments III–IX. Additional chaetotaxy is as figured, except that an occasional specimen may have 1–3 additional short tergocentral setae on segments VII and VIII.

Male genitalia (Fig. 6) with basal apodeme uniformly sclerotized, lateral margins convex. Parameres elongate and tapered, each with a short subterminal seta. Mesosomal plate with 2 pairs of sensilla and with the distal margin irregular.

Specimens of both sexes from the type host have been examined and found to be indistinguishable from those of the other hosts listed. The wide range of hosts infested is in sharp contrast to the high degree of host specificity of the species recognized by Ansari (1956) from the Corvidae.

Dimensions (in mm.). Male: total length, 1.36–1.75; head length, 0.33–0.38; head width, 0.28–0.33; prothorax width, 0.17–0.23; pterothorax width, 0.26–0.35; abdominal width, 0.32–0.48. Female: total length, 1.63–2.11; head length, 0.35–0.42; head width, 0.29–0.36; prothorax width, 0.17–0.24; pterothorax width, 0.27–0.37; abdominal width, 0.32–0.57.

Material examined: 3 ♀ from *Jynx ruficollis cosensi* Grant from Kenya, Africa; 1 ♂ from *Colaptes auratus* (L.) from Iowa, U.S.A.; 3 ♀ from *Asyndesmus lewis* (Gray), from Oregon, U.S.A.; 11 ♂, 10 ♀ from *Melanerpes erythrocephalus* (L.) from Minnesota and Nebraska, U.S.A.; 4 ♂, 16 ♀ from *Melanerpes formicivorus* (Swainson) from California, U.S.A.; 3 ♀ from *Melanerpes formicivorus bairdi*, Ridgway from California, U.S.A.; 7 ♂, 7 ♀ from *Melanerpes carolinus* (L.) from Indiana, Iowa and Mississippi, U.S.A.; 4 ♂, 3 ♀ from *Melanerpes carolinus zebra* (Boddaert) from Kansas, U.S.A.; 2 ♀ from *Sphyrapicus varius* (L.) from San Louis Potosi, Mexico; 2 ♂, 6 ♀ from *Sphyrapicus v. varius* (L.) from Texas, U.S.A.; 1 ♀ from *Sphyrapicus thyroideus* (Cassin) from California, U.S.A.; 2 ♀ from *Dendrocopos major* (L.) from Glostershire, England; 5 ♂, 5 ♀ from *Dendrocopos major anglicus* (Hartert) from Somerset, England; 18 ♂, 32 ♀ from *Dendrocopos albolarvatus* (Cassin) from California, U.S.A.; 4 ♂, 4 ♀ from *Dendrocopos villosus* (L.) from California, Minnesota, Nebraska and Vermont, U.S.A.; 1 ♂, 2 ♀ from *Dendrocopos villosus harrisi* (Audubon) from Oregon, U.S.A.; 3 ♂, 15 ♀ from *Dendrocopos villosus hyloscopus* (Cabanis & Heine) from California, U.S.A.; 2 ♂, 7 ♀ from *Dendrocopos pubescens* (L.) from Minnesota, Nebraska, New York and Wisconsin, U.S.A.; 2 ♀ from *Dendrocopos pubescens medianus* (Swainson) from New York, U.S.A.; 7 ♂, 10 ♀ from *Dendrocopos borealis* (Vieillot) from Florida, Mississippi and North Carolina, U.S.A.

Picicola superciliosus (Nitzsch, 1866) NEW COMB.

Type host: *Dendrocopos m. medius* (L.)

Nirmus superciliosus Nitzsch, 1866, *in* Giebel, Z. ges. Nat. Wiss., **28**: 370. Type host: *Dendrocopos medius.*

Brüelia superciliosa (Nitzsch); Hopkins and Clay, 1952, Check list of genera and species of Mallophaga: 62. Host: *Dendrocopos m. medius.*

? Brueelia superciliosa (Nitzsch); Zlotorzycka, 1964, **12**: 261. Type host: *Dryobates m. medius.*

I concur with Zlotorzycka (1964:261) in questioning the placement, by Hopkins and Clay (1952:62), of *Nirmus superciliosus* Nitzsch in *Brueelia.*

The original description, as cited below, leaves much to be desired. It does not agree entirely with any of the species known from the Picidae. The Nitzsch types were destroyed during World War II.

"54 *N. superciliosus* N. *Picus medius*
Sehr ähnlich dem vorigen, aber mit dunklen Rückenflecken und deutlicher Stirnsignatur."
The previous species: N. 53 is *Nirmus candidus* Nitzsch and it is clearly a *Picicola* species. Giebel (1874:150) redescribed *N. superciliosus* N.; this description however, is equally vague and has no figures.

Assuming that the host is correct and that the species in question belongs to a genus known from the Picidae, it would appear to belong best in *Picicola.* No reference is made to the oval abdomen and dark tergites, or any of the other characters generally included in the early descriptions of *Penenirmus* species. Its comparison with *N.* (= *Picicola*) *candidus* and the "dunklen Rückenflecken" leads me to believe it is not a species of *Brueelia.* The *Picicola* species group to which *P. candidus* belongs (Dalgleish, 1969:105) is similar in form to the group (SNODGRASSI GROUP) including species known from *Dendrocopos* spp. except that the latter has conspicuous dark pigmented areas on the head, thorax and abdomen.

Unfortunately, specimens from the type host were not available for this study. Nevertheless it does seem appropriate to reconsider the previous interpretation and assign this species to *Picicola.*

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Observations on the Corneal Nipples in Mosquitoes (Diptera)

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Abstract: The ommatidia of *Aedes aegypti* are densely covered with corneal nipples which are rather regularly arrayed over the surface. Although there was no special distribution pattern the inter-ommatidial spaces of the male *A. aegypti* had nipple-like projections. It is possible that the nipples may be scratched off the cornea with no damage to the underlying structures.

The compound eye of the mosquito *Aedes aegypti* L. is composed of approximately 400 ommatidia (Figs. 1 and 2) with more in females than in males (Christophers, 1960). Each ommatidium is made up of an external dioptric apparatus and an underlying receptor layer of retinula cells (Brammer, 1970). The dioptric apparatus consists of an outer hardened cuticular cornea, a biconvex lens, and associated pigment cells. Its function is the transmission of light to the rhabdomere—that portion of the cell in which the photosensitive visual pigment is located (Goldsmith, 1964; Langer, 1966; Langer & Thorell, 1966).

The initial structure which light strikes as it enters the eye is the cornea. The corneal surface of each ommatidium is covered with an array of protuberances, first described in a night moth by Bernhard & Miller (1962), who called them corneal nipples. Since that time corneal nipples have been seen in a wide variety of insects. Indeed, grouping of insects according to corneal types has recently been accomplished on the basis of examination of 361 different species from most insect orders (Bernhard, Gemne & Sällström, 1970). The present report deals with observations which have been made on the corneal nipples in various species of mosquitoes.

MATERIALS AND METHODS

Adult *Aedes aegypti* mosquitoes were obtained from eggs supplied by Dr. George Craig, Jr. of the University of Notre Dame. They were examined by both conventional transmission electron microscopy (TEM) and by scanning electron microscopy (SEM). Males and females of 7 other species of mosquitoes obtained from field collections were also examined by SEM. These were *Aedes excrucians*, *A. vexans*; *Anopheles quadrimaculatus*, *A. sinensis*; *Theobaldia melanura*; *Culex pipiens* and *Masonia perturbans*.

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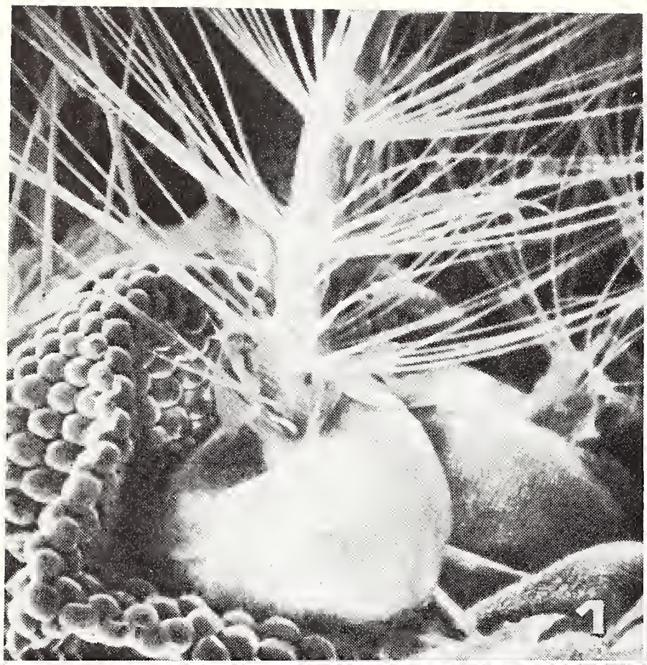

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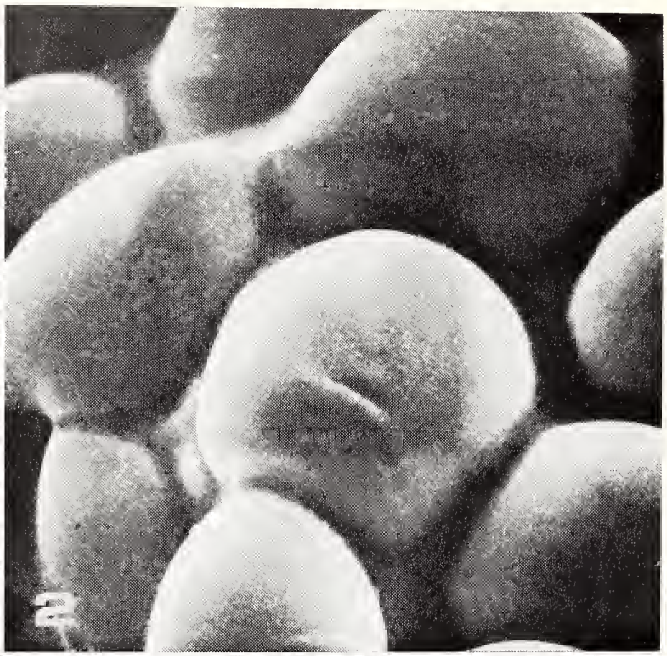

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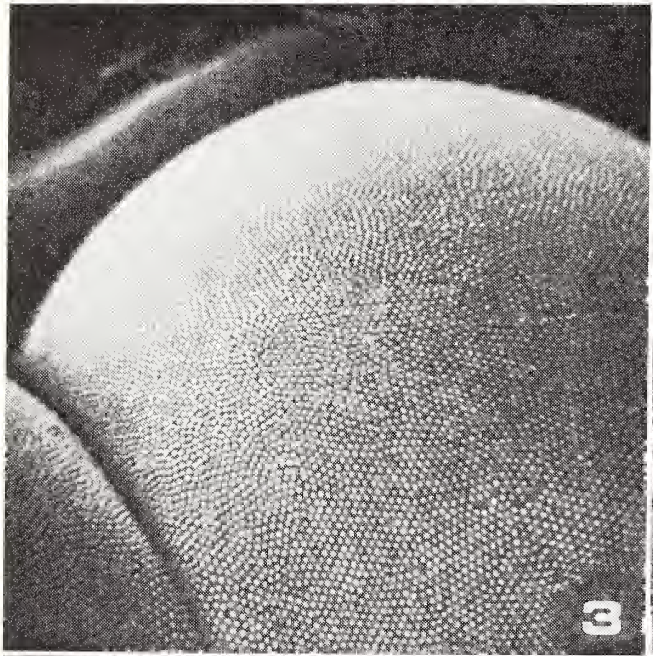

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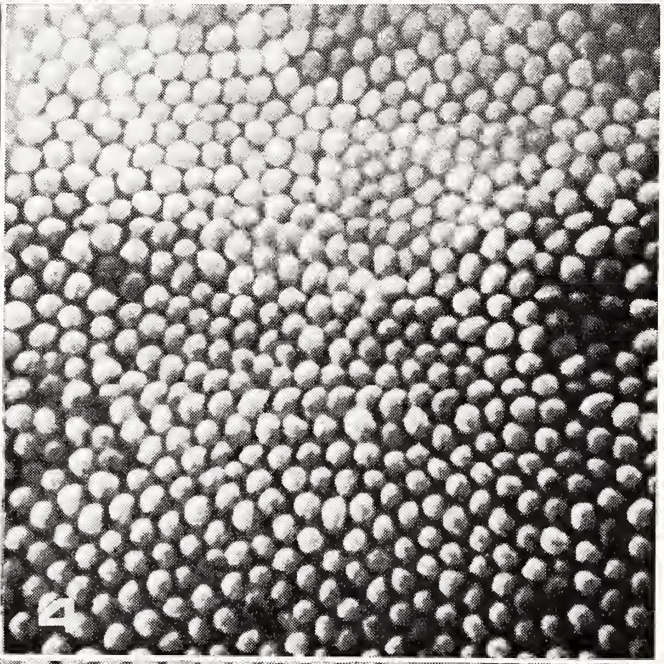

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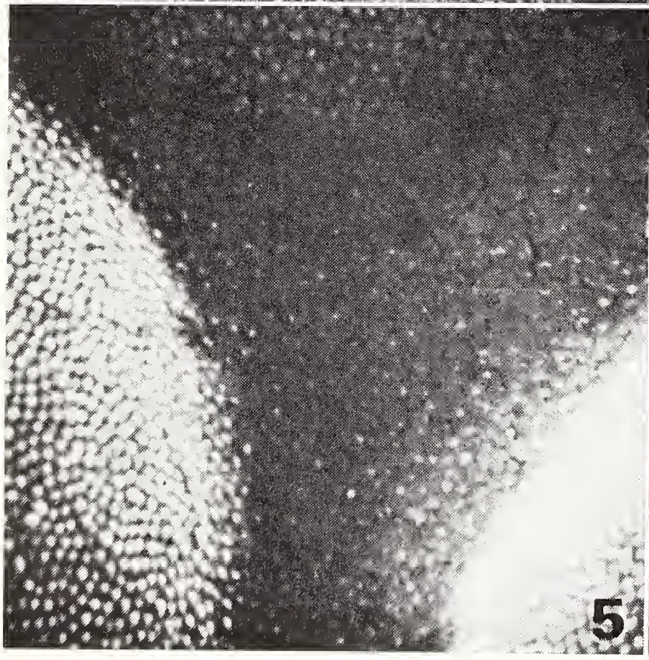

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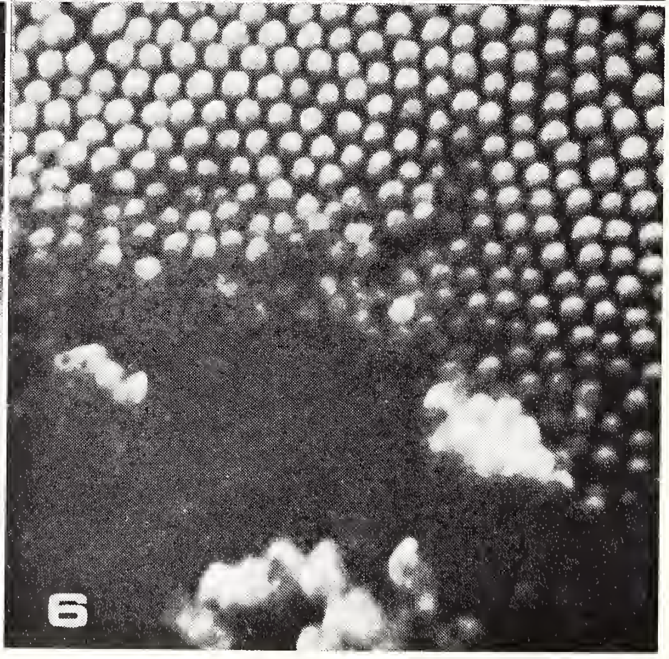

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Compound eyes were prepared for TEM by fixation for one hour in cold 5 percent veronal buffered glutaraldehyde, followed by a thirty minute buffer wash and an additional one hour fixation in cold 1 percent buffered osmium tetroxide. They were left overnight (12 to 18 hours) in cold buffer wash, and the following morning were again placed in 1 percent osmium tetroxide for one hour. They were then dehyrated in a graded series of cold acetone and embedded in an Epon-Araldite mixture (Mollenhauer, 1964). Sections were cut on glass knives and stained with uranyl acetate (saturated in the 70 percent acetone dehydration step) and lead hydroxide (Millonig, 1961). The sections were examined either with a Hitachii HU 11A or a Phillips 200 electron microscope.

The compound eyes were prepared for SEM by using aluminum paint to cement the dried specimens to stubs in such a position that both eyes could be viewed by rotation of the stub. All surfaces were coated in a vacuum chamber with approximately 200 Å of gold. Specimens were examined with a Cambridge Steroscan Mark II SEM.

RESULTS AND DISCUSSION

Scanning electron microscopy reveals the ommatidia are densely covered with corneal nipples (Figs. 3 and 4) which are rather regularly arrayed over the surface of each ommatidium. Measurements made from nipples which have been cut longitudinally and examined by TEM show that they are about 200 mu in height and 150 mu across at their base (Fig. 7). These observations agree with those made by Bernhard et al. (1970), who found similar-sized nipples on the cornea of several species of mosquitoes.

There appears to be no special pattern to the nipples with respect to either the sex of the mosquito or to the different species studies. However, it was noted that in the inter-ommatidial spaces of male *Aedes aegypti* many nipple-like projections are found (Fig. 5). No such projections have been seen in the males of other species examined, nor in any of the females. It is difficult to think of a functional role in vision which these nipple-like projections might serve, for secondary pigment cells are the only structures found below the cuticle in the inter-ommatidial spaces. The function of these secondary pigment cells is the screening of oblique light rays from the photoreceptive portion of the ommatidium (Höglund, 1965).

The appearance of the inter-ommatidial projections in the males, but not in the females, may be related to developmental differences between the two sexes. In the developing eye of both sexes the primary pigment cells are first found lying distal to the cone cells, and are involved in the formation of the

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Figs. 1–6. *Aedes aegypti* ♂. Fig. 1. Ommatidia and antennae 100×. Fig. 2. Ommatidia 2,000×. Fig. 3. Ommatidia showing corneal nipples 5,000×. Fig. 4. Corneal nipples 10,000×. Fig. 5. Inter-ommatidial projections 6,000×. Fig. 6. Corneal nipples scratched from surface of ommatidia 10,000×.

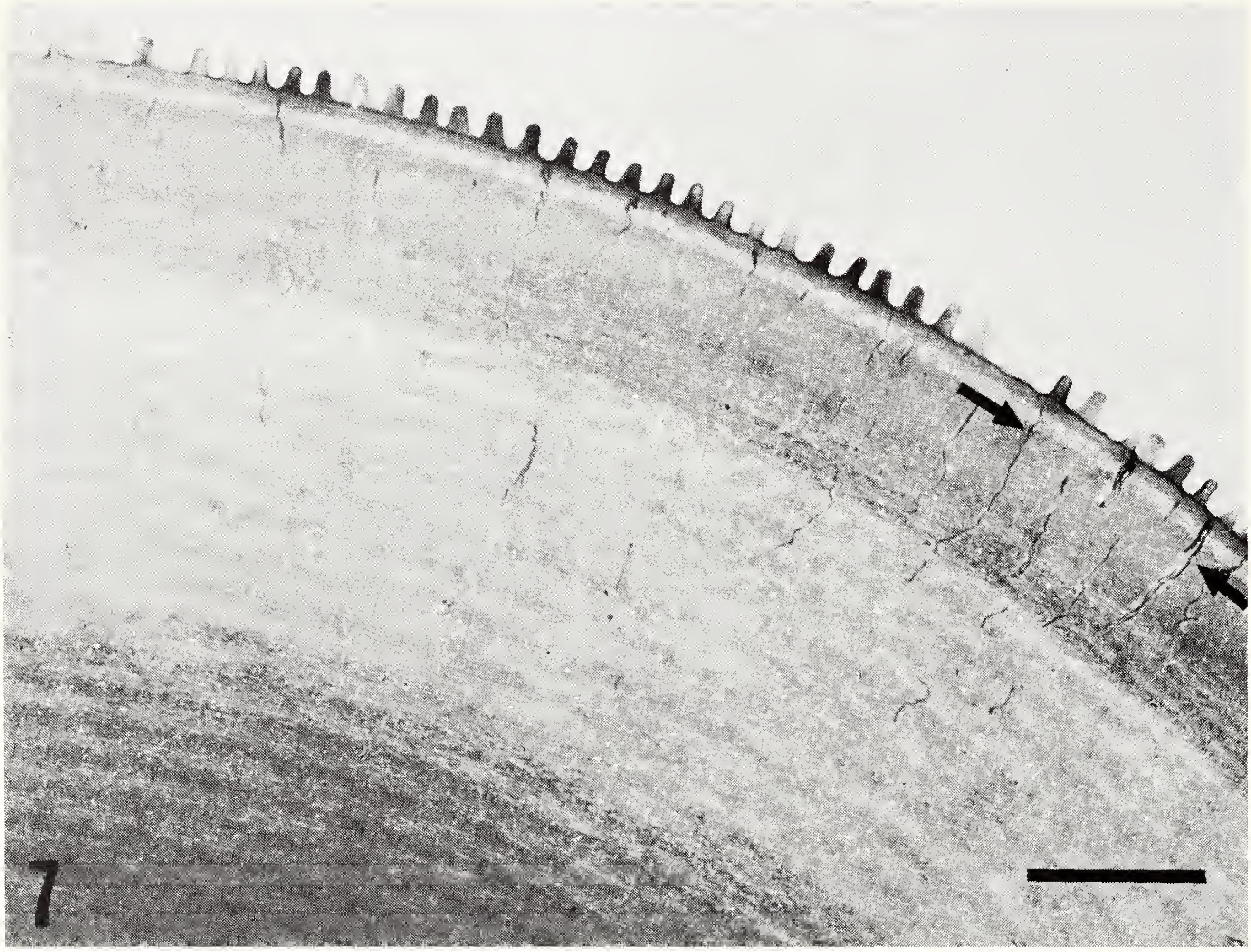

Fig. 7. The cornea and a portion of the lens in an adult *Aedes aegypti.* The plane of the section is at right angles to the surface of the eye. Epicuticular filaments are indicated by arrows. 10,000×.

cornea and the lens. As development proceeds, however, the primary pigment cells move peripherally, become pigmented, and eventually completely surround the cone (Goldsmith, 1964). In *Aedes aegypti* adults, the males are smaller in size than the females, and this is also true of their ommatidia. The reduction in ommatidial size, however, is not fully proportional to the smaller size of the female (Christophers, 1960). It is possible, then, that in the developing eye

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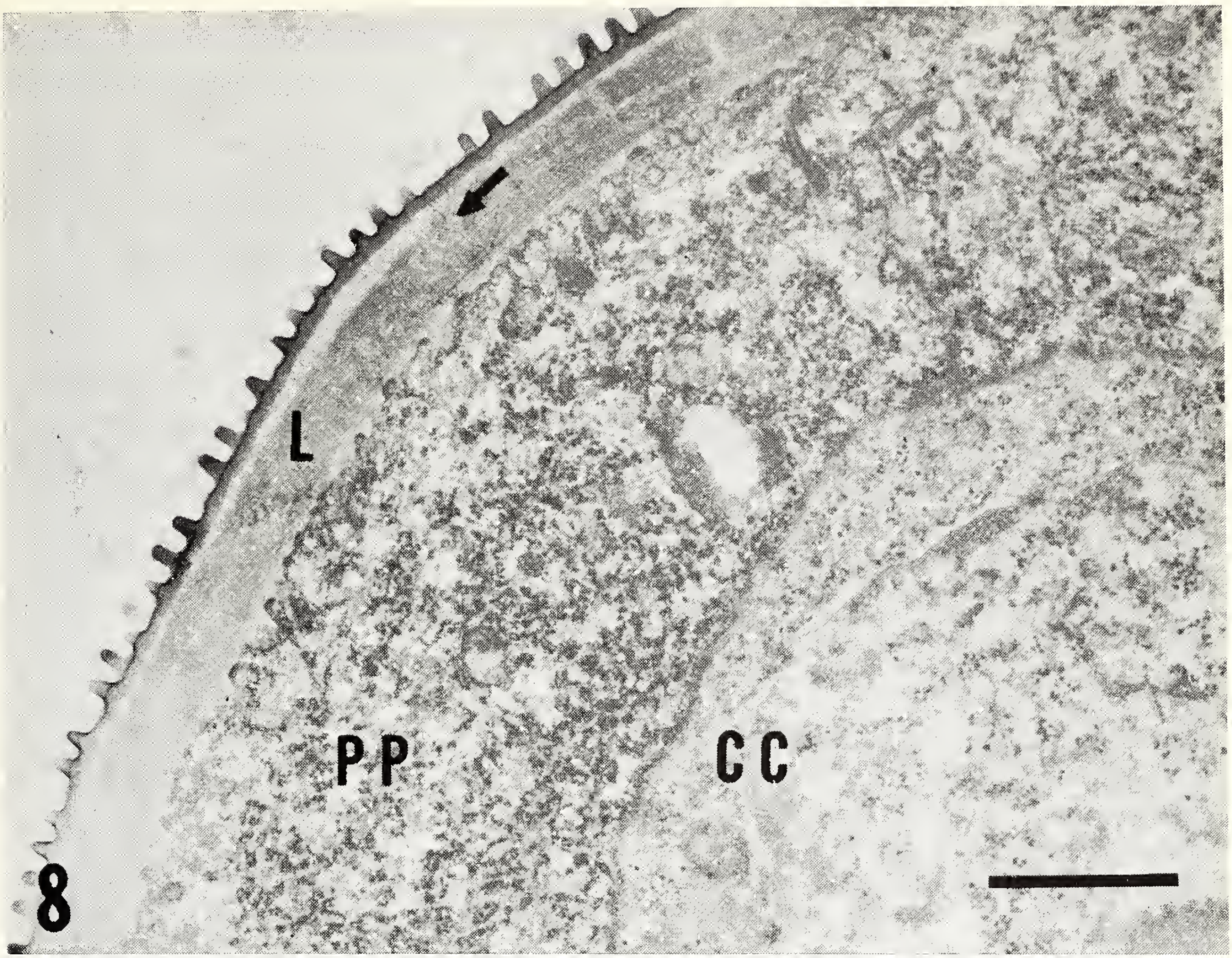
Fig. 8. The developing cornea and lens in the mid-pupal stage of *Aedes aegypti.* The arrow indicates an epicuticular filament which passes completely through the lens material (L) that has already been deposited. The underlying epidermal cells (PP), which will become the primary pigment cells of the adult ommatidium, have their surface adjacent to the lens material thrown into numerous folds. A cone cell (CC) with its large nucleus is seen at lower right. The solid line represents one micron. 10,000×.

Fig. 9. The developing eye in a very early pupal stage of *Aedes aegypti.* Lens material (L) is being deposited in small amounts by the future primary pigment cells (PP), but no corneal nipples can be seen at this time. The solid line represents one micron. 10,000×.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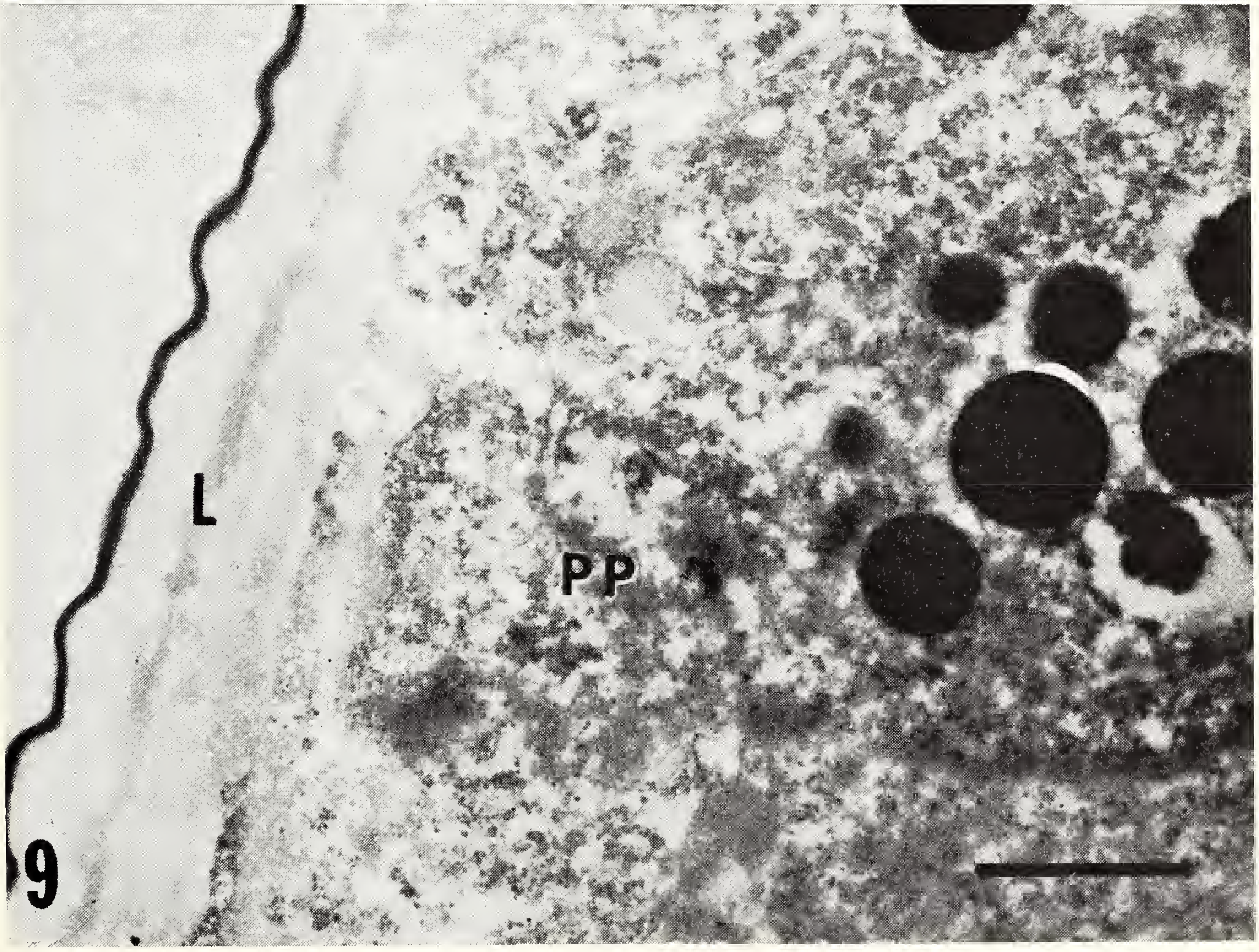
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of male pupae the primary pigment cells cause the formation of nipples in an area of cuticle larger in size than actually needed to form the cornea over each ommatidium in the adult, while such is not the case in the females. Although entirely speculative, this could explain the appearance of nipple-like projections in the inter-ommatidial spaces of males, but not females in *A. aegypti.*

In eyes which have been sectioned longitudinally the material within each nipple appears much the same as that found in the cortical region of the lens (Fig. 7). Also seen in this plane are filaments which are oriented at right angles to the surface of the eye. These filaments are confined to the superficial region of the adult lens. They are less prominent in the developing lens of the pupae, but nevertheless often extend through the entire layer of the lens material which has been deposited (Fig. 8). The filaments do not penetrate the body of the nipples, but rather make contact with the corneal surface between the nipples (Figs. 7 and 8). Similar filaments have been described in other regions of insect cuticle. Locke (1966) called such structures wax canal filaments, but Filshie (1970) suggests they should be called epicuticular filaments, since they are also found in certain insects whose cuticle lack the waxy layer.

The surface of the primary pigment cells which lie just beneath the developing lens is thrown into a series of folds, or microvilli. These microvilli are easily seen in mid-stage pupae before much lens material has been deposited, but yet after the nipples are well formed (Fig. 8). Although sometimes present, they are much less obvious in very early pupae, and no nipples can be seen at this time either (Fig. 9). Microvilli have previously been associated with corneal nipple formation in other insects (Gemne, 1966). Similar microvilli are also present between the lens and the underlying cone cells in the adult ommatidium (Brammer, 1968).

It appears possible that the nipples can be scatched off the cornea with no apparent damage to the underlying structures, for vacant areas are sometimes seen on the ommatidial surfaces with the SEM (Fig. 6). This may also explain why some nipples appear to be absent in TEM micrographs (Figs. 7 and 8).

The function of the corneal nipples in mosquitoes is still speculative. Microwave experiments on dielectric models of the lens (Bernhard, Miller and Møller 1963, 1965), combined with spectrophotometric measurements made from pieces of cornea (Miller, Møller and Bernhard, 1966), have shown that the nipples act as an impedance transformer which enhances transmission of visible light into the eye. Although the increase in transmitted light is relatively small (about 5 percent of the incident light), it may be of significance in those insects such as mosquitoes which are active at night.

It may also be possible to apply the principles of fiber optics to the corneal nipples. Kapany (1960) states that when one end of a fiber bundle is fitted to a curved surface, and the other end to a flat surface, the image delivered at the focal plane behind the curved surface is not only undistorted, but also is sharper and brighter. If the corneal nipples which are regularly scattered over the curved surface of the ommatidium behave as fiber optics, and if the transmission characteristics of the underlying lens is appropriate, a sharper, brighter image could be delivered to the rhabdom than would have been possible in the absence of the nipples. The studies of Bernhard et al. (1963, 1965, 1966), while showing the role of the nipples with respect to light transmission, would not necessarily have detected any contributions they might make toward increased resolution.

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Bionomics of *Dysdercus koenigii* Fabr. (Hemiptera: Pyrrhocoridae)[1]

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Received for Publication May 22, 1971

Abstract: The cotton stainer, *Dysdercus koenigii* Fabr., is an important pest of cotton. By feeding on half opened cotton bolls and seeds, the oil content and seed viability is reduced and the excreta of the insect spoils the cotton lint. Eggs are oval, smooth, creamy yellow in color with an average incubation period of 6.18 days. The period of the first, second, third, fourth and fifth instars are from 3 to 4, 3 to 4, 3 to 5, 6 to 8 and 12 to 16 days, respectively. The adults live from 9 to 25 days and the life cycle extends from 51 to 61 days. This bug is present throughout the year and also feeds on okra, hollyhock, eggplant and other malvaceous plants. The alternate hosts reported for the first time are falsa, rohan and eggplant.

The cotton stainer, *Dysdercus koenigii* Fabr., is indigenous to India and reported from all cotton producing areas. It causes considerable damage by reducing plant vigour, staining the lint, reducing the oil content and the germination of seeds.

In the Vidarbha region of Maharashtra state, no substantial research has been done on *D. koenigii* Fabr., and this study was undertaken to gain information on the bionomics and importance of this species.

MATERIALS AND METHODS

LABORATORY STUDIES: The laboratory rearing of *D. koenigii* was started from adults collected from okra fields, at room temperature (24° to 25° C.). Cages 4″ × 4″ and goblets 3″ in diameter and 4″ in height were used for the rearing. Initially, okra fruits and later, half opened cotton bolls were provided as food. In the open field area (near rearing room), potted plants covered with muslin hoods were used for observation of egg laying and feeding habits.

Observations were made on eggs to determine color, size shape and incubation period, and on nymphs to determine the duration of the instars, distinctive morphological characters and the feeding habits. The measurements of different body parts of various instars were made with an occular micrometer. Precopulation period, copulation period, oviposition period, the egg laying capacity of female and the longevity of males and females were also recorded.

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[1] Part of M.S. thesis submitted to Nagpur University, Nagpur, India.

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Table 1. Measurements in mm. of *D. koenigii* Fabr.

		Egg	Instar					Adults	
			First	Second	Third	Fourth	Fifth	Male	Female
Length of egg	Min.	1.06							
	Max.	1.20							
	Ave.	1.13							
Width of egg	Min.	0.78							
	Max.	0.88							
	Ave.	0.80							
Length of body	Min.		1.40	2.00	4.00	5.00	8.00		
	Max.		1.70	2.40	4.50	6.00	10.10		
	Ave.		1.56	2.10	4.12	5.50	9.38	13.01	15.04
Width of body	Min.		0.78	1.30	1.60	2.50	3.25		
	Max.		0.81	1.60	1.80	3.00	3.50		
	Ave.		0.80	1.50	1.77	2.55	3.30	7.04	9.07
Length of antennae	Min.		0.94	0.80	2.45	4.36	6.00		
	Max.		0.96	1.00	2.90	4.50	6.50		
	Ave.		0.94	0.90	2.57	4.46	6.22	9.00	9.07
Distance between eyes	Min.			0.50	0.60	0.67	0.87		
	Max.			0.60	0.80	0.90	0.90		
	Ave.			0.56	0.70	0.80	0.88	1.57	1.83
Length of proboscis	Min.		0.94	1.80	2.40	3.79	5.58		
	Max.		0.96	2.10	3.00	4.20	6.62		
	Ave.		0.95	1.94	2.60	4.00	6.34	6.87	7.05
Length of wing pads	Min.					0.70	2.20		
	Max.					1.00	2.50		
	Ave.					0.99	2.44		
Length of fore wings	Min.								
	Max.								
	Ave.							22.04	25.99
Length of hind wing	Min.								
	Max.								
	Ave.							9.03	11.87

FIELD STUDIES: Four fields were selected to study the periodical infestation of *D. koenigii* on cotton; one each to the north, the south, the east and the west of the insectary. Fortnightly observations were taken on the above fields. Observations on hollyhock, falsa, silk-cotton, eggplant and rohan plants (without muslin hood) were made to see whether they serve as alternate hosts.

OBSERVATIONS

LABORATORY STUDIES: Eggs were laid near half opened cotton bolls in rearing cages and goblets. On potted plants, the eggs were laid in cracks and crevices of soil and covered by loose soil or dried leaves. The egg laying capacity of each female varied from 27 to 144, with each egg oval in shape, soft and creamy yellow in color. Three days later, each egg had three red spots, two on anterior and one on posterior side. The incubation period varied from 4.73 to 7.33 days with an average of 6.18 days. Measurements of eggs are given in Table 1.

Hatching was achieved by rupturing of the chorion along the dorsal midline. The nymph emerged with the dorsal surface oriented downward and the ventral surface upward. The elapsed time from wriggling of egg to hatching was 8 to 12 minutes.

The newly hatched nymph was yellowish in color with transparent legs and antennae. All tarsae had 3 segments and the antennae 4 segments. Three distinct spots, the opening of stink glands, were observed on the intersegmental membranes of the abdomen, between segments 3 to 4, 4 to 5, and 5 to 6. The duration of the instar was 3 to 4 days. Measurements of various organs and regions are given in Table 1.

The second instar nymph was orange in color immediately after molting but changed to a dark red in the post molting period. The rostrum had 4 segments. Duration of second instar was from 3 to 4 days. The various measurements are given in Table 1.

The most important feature of the third instar nymph was the appearance of wing pads. As previously observed, the stink gland openings were prominent. The three transverse white bands were observed on the ventral side of second, third and fourth sternal plates. This nymphal stage extended from 3 to 5 days. Measurements are given in Table 1.

The fourth instar nymph was blood red in color. A characteristic of this nymph was the presence of a faint white collar behind the head. The stink gland openings were more conspicuous. An additional transverse white band was observed on ventral side of fifth abdominal sternal plate. This instar lasted from 6 to 8 days. Measurements are given in Table 1.

The white collar, first observed in the previous instar became more prominent in the fifth instar. Wing pads extended to the fourth abdominal segment. A fifth transverse ventral white band was observed on the sixth abdominal sternal plate. This instar lasted from 12 to 16 days. Measurements are given in Table 1.

Adults emerged in the final molt which took 22 to 25 minutes. Wings were unfolded within 15 to 18 minutes. The newly molted adults were orange in color but changed to blood red within 4 to 5 hours. Morphologically males and females were similar except for external genitalia and body size. The measurements of different parts of males and females are given in Table 1.

The precopulation period varied from 3 to 5 days after emergence of the imago from the last nymphal molt. Copulation continued from 7 to 70 hours and the oviposition period from 1 to 5 days after copulation. Males lived from 9 to 24 days and females from 14 to 25 days. The sex ratio of male to female was 50.50 to 48.50. The total cycle varied from 51 to 61 days.

The feeding habits of nymphs and adults were similar except for their gregariousness during feeding. When food was scarce nymphs and adults were commonly cannibalistic.

Both nymphs and adults attacked half opened cotton bolls, in commerce this reduces the oil content and power of germination of seeds and the yellow insect excreta gives a dirty yellow color to the lint further reducing its market price. In addition newly laid eggs and insects may be crushed during picking, increasing the staining of the lint.

FIELD STUDIES: Under field conditions from October to February, cotton was the insects main source of food and there was a population peak period from December to January. From March to June, the insect was present on hollyhock, irrigated cotton and silk-cotton and from July to September, okra served as an alternate host. It was also observed that okra, silk-cotton, eggplant, rohan, falsa, hollyhock and other malvaceous plants also served as alternate hosts.

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Distribution of *Balclutha* in the Bahama Islands, Newfoundland, and Panama[1] (Homoptera: Cicadellidae)

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Abstract: New locality records are presented for eight species of *Balclutha* from the Bahama Islands: *B. caldwelli*, *curvata*, *flavescens*, *floridana*, *guajanae*, *hebe*, *incisa*, and *neglecta*. *B. arctica* is recorded from Newfoundland and *B. delongi* from Panama; both are new distributional records. Supplementary information on size, nomenclature, and method of collecting is included.

During the summer of 1970, I determined more than 875 specimens of *Balclutha* spp. sent to me by the American Museum of Natural History. More than 700 of these were collected from the Bahama Islands, most during the Van Voast—AMNH Bahamas Islands Expeditions between January and May of 1953. A study of the specimens revealed no new taxa, but because they constitute new locality records, the eight species determined are reported here. In addition, *B. arctica* is reported from Newfoundland and *B. delongi* from Panama. The specimens of *delongi* were lent by Dr. James P. Kramer from the collection of the United States National Museum.

Three species, *incisa*, *caldwelli*, and *hebe*, were taken at lights in the Bahamas. None of the species determined are endemic to the Bahamas; all species determined are rather widely distributed in the West Indies and surrounding areas. Measurements are reported only when they exceed the ranges previously recorded for the Western Hemisphere (Blocker 1967 and 1968).

Species found in the Bahama Islands are:

Balclutha caldwelli Blocker. Thirty-six specimens: Abaco Cays, Elbow Cay, Hope Town, 4 May 1953, Hayden; Eleuthera Isl., New Portsmouth (Rock Sound), 28 Mar. 1953, Hayden and Giovannoli; Great Inagua Isl., 12 miles N Matthew Town, 29 Jan. 1953, Hayden and Giovannoli; New Providence Isl., Nassau, 3 Jan. 1953, at light, Hayden.

NOTES: Dorsal length of males ranged from 3.0 to 3.5 mm. A widespread tropical and subtropical species.

Balclutha curvata Caldwell. Twenty-eight specimens: Crooked Isl., Landrail Point, 5 Mar. 1953, Hayden; Great Inagua Isl., 12 miles N Matthew Town, 29

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[1] Contribution No. 1057, Department of Entomology, Kansas Agricultural Experiment Station, Kansas State University, Manhattan, Kansas 66502.

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Jan. 1953, Hayden and Giovannoli; Long Isl., Deadman's Cay, 11 Mar. 1953, Hayden.

NOTES: Dorsal length of males ranged from 2.7 to 2.9 mm; pronotal width from .725 to .800 mm. Closest previous records are Florida and Puerto Rico.

Balclutha flavescens (Baker). Ten specimens: Great Inagua Isl., Matthew Town, 31 Jan. 1953, Hayden and Giovannoli; South Bimini Isl., Bahamas, B. W. I., Aug. 1951, C. and P. Vaurie.

NOTE: Closest previous records, Florida and Cuba.

Balclutha floridana (DeLong and Davidson). Thirty-six specimens: Abaco Cays, Allen's Cay, 9 May 1953, Hayden and Giovannoli; Eleuthera Isl., Jame's Cistern, 1 Apr. 1953, Hayden and Giovannoli; Exuma Cays, Staniard Cay, 13 Jan. 1953, Hayden; Grand Bahama Isl., West End, 12 May 1953, Hayden and Rabb; Great Abaco Isl., Marsh Harbour, 6 May 1953, Hayden and Giovannoli; New Providence Isl., Nassau, 3 Jan. 1953, Hayden and Giovannoli; Rum Cay, nr. Port Nelson, 16 Mar. 1953, Hayden.

NOTE: A common and widespread species; closest previous records, Florida and Cuba.

Balclutha guajanae (DeLong). Seventeen specimens: Cat Isl., Bennett's Harbour, 24 Mar. 1953, Hayden; Exuma Cays, Staniard Cay, 13 Jan. 1953, Hayden; Great Inagua Isl., Matthew Town, 31 Jan. 1953, Hayden and Rabb; Turks and Caicos Isl., Grand Turk Isl., 19 Feb. 1953, Hayden and Giovannoli.

NOTES: Theron (1970) has stated that *guajanae, rosea* (Scott), and *longiforma* (Cogan) are very closely related and probably conspecific. A study of these forms from the entire range of occurrence is indicated. Range of *guajanae* in the Western Hemisphere is primarily tropical and subtropical; *rosea* is primarily European and *longiforma* is reported from Africa.

Balclutha hebe (Kirkaldy). Forty-seven specimens: Crooked Isl., Landrail Point, 5 Mar. 1953, Hayden; Eleuthera Isl., New Portsmouth (Rock Sound), 28 Mar. 1953, Hayden; Grand Bahama Isl., West End, 12 May 1953, Hayden and Rabb; Great Abaco Isl., Marsh Harbour, 6 May 1953, Hayden and Giovannoli; New Providence Isl., Nassau, 3 Jan. 1953, at light, Hayden.

NOTE: A widespread species, primarily in tropical and subtropical areas.

Balclutha incisa (Matsumura). Three hundred twenty-eight specimens: Abaco Cays, Elbow Cay, Hope Town, 4 May 1953, Hayden; Berry Isl., Little Harbour Cay, 1 May 1953, Hayden and Giovannoli; Cat. Isl., Bennett's Harbour, 24 Mar. 1953, Hayden and Giovannoli; Eleuthera Isl., Jame's Cistern, 1 Apr. 1953, at light, Hayden and Giovannoli; Eleuthera Isl., New Portsmouth (Rock Sound), 28 Mar. 1953, Hayden; Exuma Cays, Darby Isl., 18 Jan. 1953, Hayden and Giovannoli; Exuma Cays, Big Farmer's Cay, 13 Jan. 1953, Hayden; Grand Bahama Isl., West End, 12 May 1953, Hayden and Rabb; New Providence Isl., Nassau, 16 Apr. 1953, at light, Hayden; Turks and Caico Isls., Grand Turk Isls., 19 Feb. 1953, Hayden; Turks and Caico Isls., Long Cay (S of S Caicos Isl.), 10 Feb. 1953, Hayden.

NOTE: A widespread species in temperate to tropical areas.

Balclutha neglecta (DeLong and Davidson). One hundred sixty-eight specimens: Andros Isl., Lisbon Creek (nr. S Bight), 28 Apr. 1953, Hayden; Andros Isl., Mangrove Cay, 26 Apr. 1953, Hayden; Crooked Isl., Landrail Point, 5 Mar. 1953, Hayden; Exuma Cays, Staniard Cay, 13 Jan. 1953, Hayden; Long Isl., Clarence Town, 13 Mar. 1953, Hayden and Giovannoli; Long Isl., Deadman's Cay, 11 Mar. 1953, Hayden; Mayaguana Isl., nr. Abraham Bay, 3 Mar. 1953, Hayden; San Salvador Isl., nr. Cockburn Town, 18 Mar. 1953, Giovannoli and Rabb; South Bimini Isl., Bahamas, B. W. I., May 1951, Cazier and Gertsch.

NOTE: A widespread species in temperate to tropical areas.

New distributional records from areas other than the Bahama Islands are:

Balclutha arctica Beirne. One male specimen from: Bay of Islands, Newfoundland, 7–8 Aug. (no year). Previously this species has not been reported east of Montana or the Northwest Territories.

Balclutha delongi Blocker. One male specimen from Tocumen, Panama, 17 Nov. 1952 and two males from Port of Chorrera, Panama, 8 Sept. 1952. All were collected at lights by F. S. Blanton. Previously this species has been reported only from Matto Grosso, Brazil.

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Phylogenetic Affinities of the Ant Genus *Cheliomyrmex* (Hymenoptera: Formicidae)

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Abstract: Field observations of the rarely collected ant, *Cheliomyrmex morosus* (F. Smith), are recorded. The ant is hypogaeic with a majority of its burrows appearing in the upper 6 inches of the soil. Internal and external features of the abdomen considered to be of importance in understanding the phylogeny of this ant are discussed. Included are descriptions of portions of the gastral digestive system, the reproductive system, and the sting apparatus. Malpighian tubule counts in *C. morosus* and 6 other New World dorylines are compared.

INTRODUCTION

The Neotropical ant genus *Cheliomyrmex* was established by Mayr (1870) based on worker specimens of a species that Mayr named *C. nortoni.* Wheeler (1921) indicated that these specimens were "evidently collected by Sumichrast near Mount Orizaba, in the state of Vera Cruz, Mexico." Mayr considered the genus to be morphologically intermediate between the Ponerinae and Dorylinae, and Emery (1895) eventually placed the genus in the Dorylinae. Wheeler (1921) suggested that the genus should constitute an independent tribe, the "Cheliomyrmicini," and Borgmeier (1955), in his massive revision of the New World dorylines, accepted this placement. Numerous other authors have discussed the phylogenetic affinities of the genus. Forel (1893) doubted that *Cheliomyrmex* belonged with the Dorylinae. Ashmead (1906), who placed the genus close to *Dorylus*, indicated that the genus might instead belong near the Ecitonini. Emery (1910) considered the genus to be closely related to *Labidus*, particularly *L. coecus* (Latreille), but this conclusion was later refuted by Wheeler (1921) and by Borgmeier (1954, 1955). Wheeler (1921) characterized the tribe Cheliomyrmecini as a very ancient group, "the most archaic and generalized" of all the tribes of the Dorylinae, and as being very near the ancestral stem from which both the Dorylini and Ecitonini arose in the late Cretaceous. In an examination

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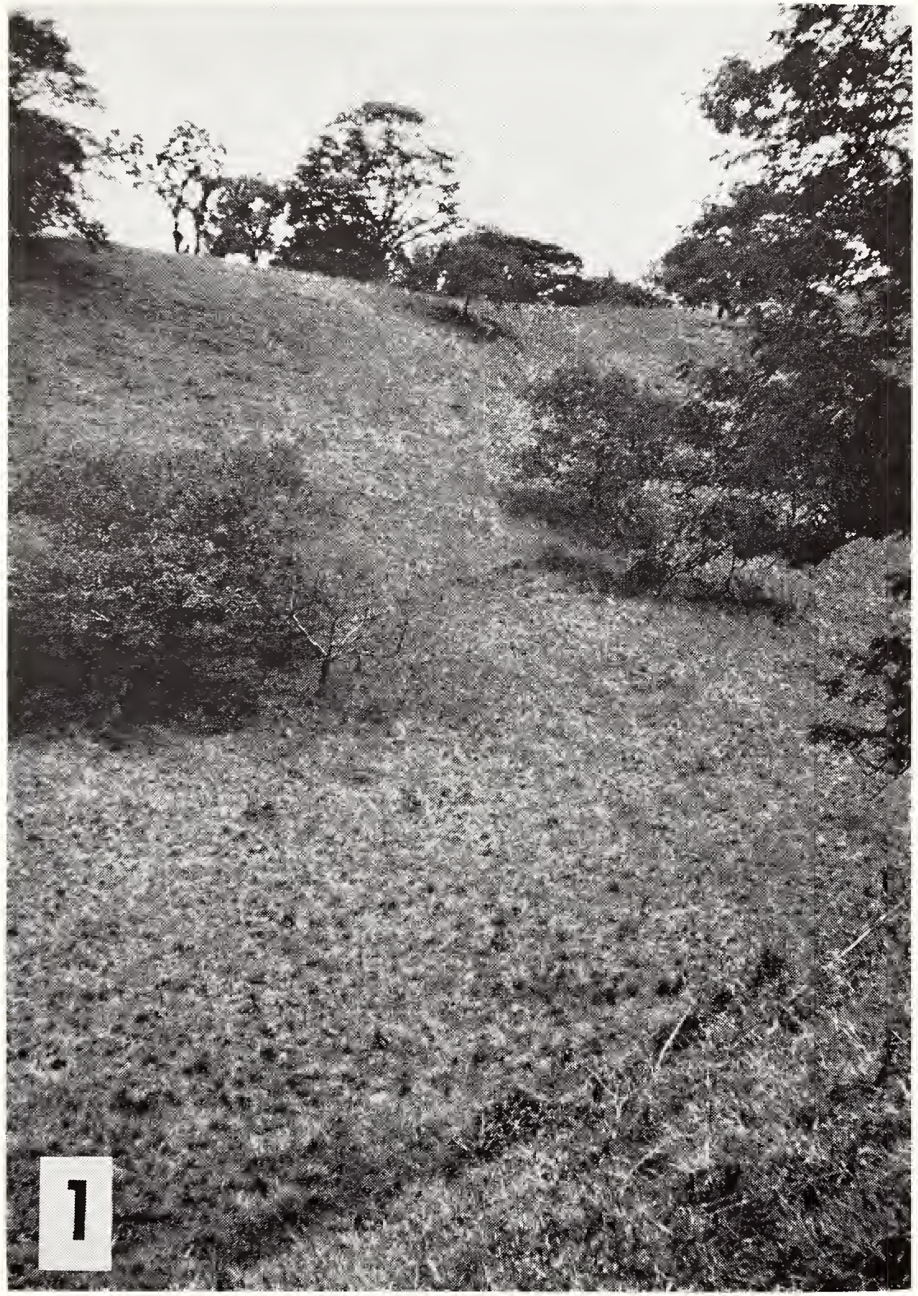

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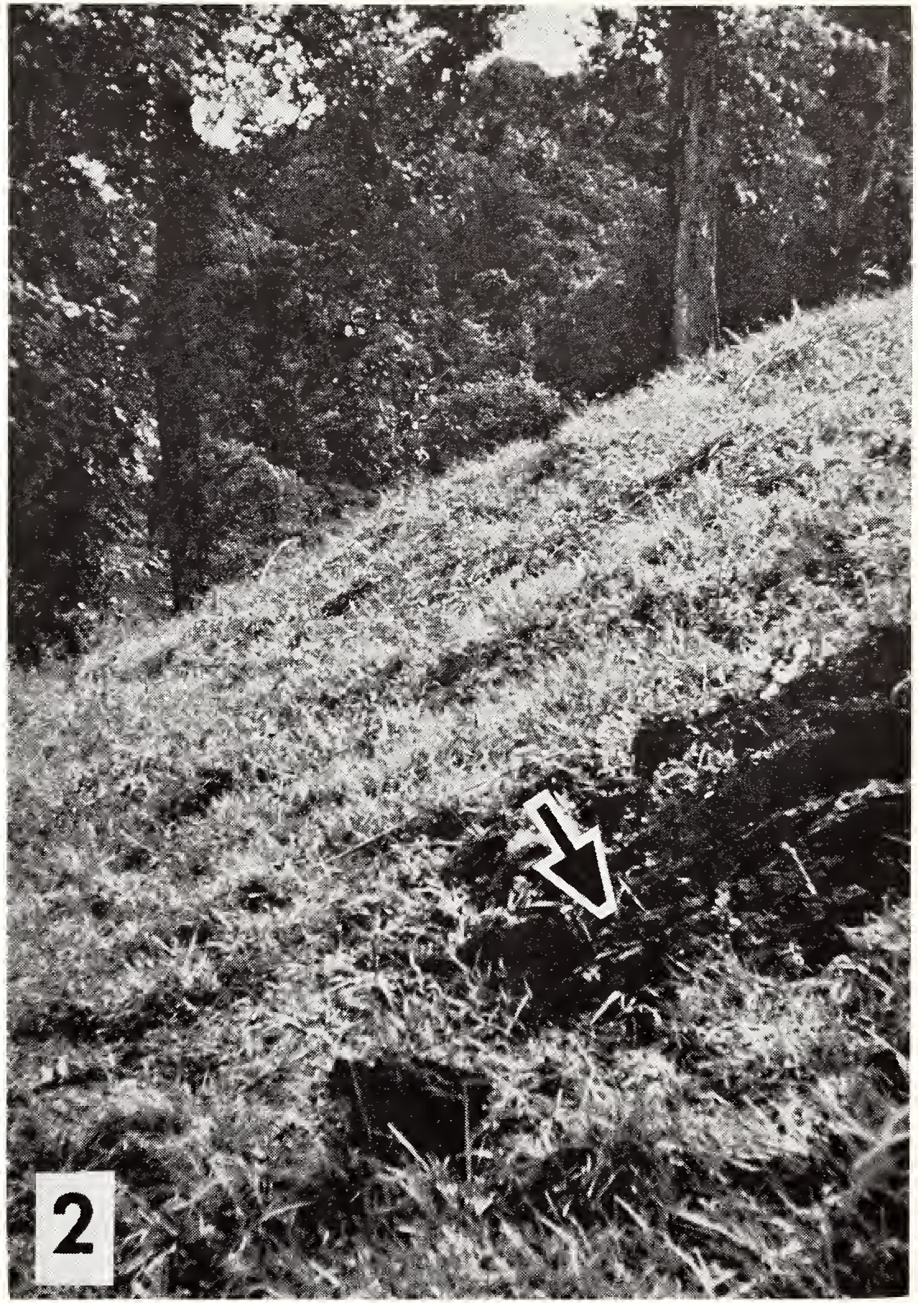

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of ant wing venation, Brown and Nutting (1950) indicated that *Cheliomyrmex* appears as the most primitively veined doryline. Gotwald (1969), in a study of mouthpart morphology, suggested that the Cheliomyrmecini and Ecitonini are closely related and together form a distinct New World group. Reid (1941) pointed out that the thorax of *Cheliomyrmex* is ecitonine in construction, and Hermann (1969) placed the stings of the Cheliomyrmecini and Ecitonini in the same morphological group.

Although Mayr erected the genus *Cheliomyrmex* and described *C. nortoni* in 1870 based on worker specimens, the male of the species was described prior to that date by F. Smith (1859) as *Labidus morosus.* That *C. nortoni* and *L. morosus* were the same species was first suggested by Emery (1910), and later Wheeler (1921) changed the name of the species from *C. nortoni* to *C. morosus.*

C. morosus has been collected only rarely and is recorded from Mexico, British Honduras, and Honduras. Most commonly this species has been collected in the state of Vera Cruz, Mexico, particularly in the vicinity of Orizaba, Cordoba, and Atoyac (Borgmeier, 1955). Because it is rarely seen in the field, little is known of its biology. In addition, the queen for this species, as well as for the entire genus, is unknown. This ant is most probably hypogaeic, but little else is known of its biology.

A colony of *C. morosus* was fortuitously discovered by Dr. Hans Reichardt while participating in a Cornell University Field Expedition to Mexico during the summer of 1965. Subsequent to this discovery and also as a member of this expedition, I observed and collected a large series of workers. In addition a number of males were collected at UV light in the village of Fortin de las Flores, Vera Cruz. The present investigation provides new information on the biology and morphology of this species based on the specimens observed and collected in the summer of 1965.

METHODS

Morphological observations were made both in the field and laboratory. The Malpighian tubule counts were performed in the field on live ants immersed in water. A quick, firm pull on the tip of the gaster with forceps, as described by Ettershank and Brown (1964), is sufficient to pull out and expose the gastral digestive system, whereupon the tubules can be easily counted. The remaining workers of the series collected were placed in Bouin's fluid. A number of these were cut in half between the alitrunk and petiole to assure more complete contact

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Figs. 1–2. Pasture, east of the Fortin de las Flores—Huatusco road, state of Vera Cruz, Mexico, in which a colony of *Cheliomyrmex morosus* was discovered. Fig. 1. General view of pasture from colony location site. Fig. 2. Colony location site (precise location indicated by arrow).

of the tissues with the fluid. The laboratory dissections were performed on this latter group of specimens. The ovaries were removed from the gaster, stained with acid fuchsin, and mounted on microscope slides in Canada balsam.

OBSERVATIONS

LOCATION AND DESCRIPTION OF THE COLONY: The colony was found beneath a decayed log situated in a pasture on 3 August. This pasture was located approximately one-half mile east of the Fortin de las Flores—Huatusco road at km 38, 2 miles south of Huatusco, in the state of Vera Cruz. This location is within the same general area as Atoyac, the type locality for the species.

The pasture was located on two small hillsides which sloped together to form a small hollow (Figs. 1 and 2). It was covered with short grasses and occasional trees. The log under which the colony was found was partially destroyed prior to noting the significance of the discovery. Most observations were made the following day when the colony was found under a fragment of the log. There appeared to be only one tunnel entrance beneath this fragment.

A few workers were observed in the vicinity of the colony entrance, but no organized columns of workers were seen. An unsuccessful attempt was made to attract more workers to the surface by placing fragments of bacon near the tunnel entrance. When one or two workers were lifted with forceps a large number of others would hang together by means of their tarsi, forming a "string" of ants. This is very similar to the behavior of army ants of the genus *Eciton* (see Rettenmeyer, 1963) where it is important in bivouac formation. This suggests that *C. morosus* might similarly cluster in subterranean locations, although such locations would certainly be restrictive to such bivouac formation.

In an effort to locate the queen, the area presumably housing the colony was excavated, eventually resulting in a trench 3 feet long by 1 foot deep and 1 foot wide. Neither the queen nor brood were found, indicating that this area may have been peripheral to the primary colony site. Although the workers had some tunnels at a depth of about 6 inches, most appeared to be located just beneath the surface. The workers sought refuge in these tunnels and could no longer be found. Similarly, Mann (1922) reported locating a small colony of *C. morosus* beneath a stone but the workers quickly disappeared in the ground. He did not attempt to dig in the area.

Upon being disturbed *C. morosus* does not respond as excitedly as do species of *Eciton* and *Labidus*. However, in defending itself, the worker bites and stings simultaneously. When attacked I found that the mandibles penetrate the superficial layers of the skin and must be pulled out. The sting is painful, comparable to a mild bee sting, and results in the formation of a small circular welt about 7 mm. in diameter. Wheeler (1921) described the sting of *C. megalonyx* Wheeler as painful.

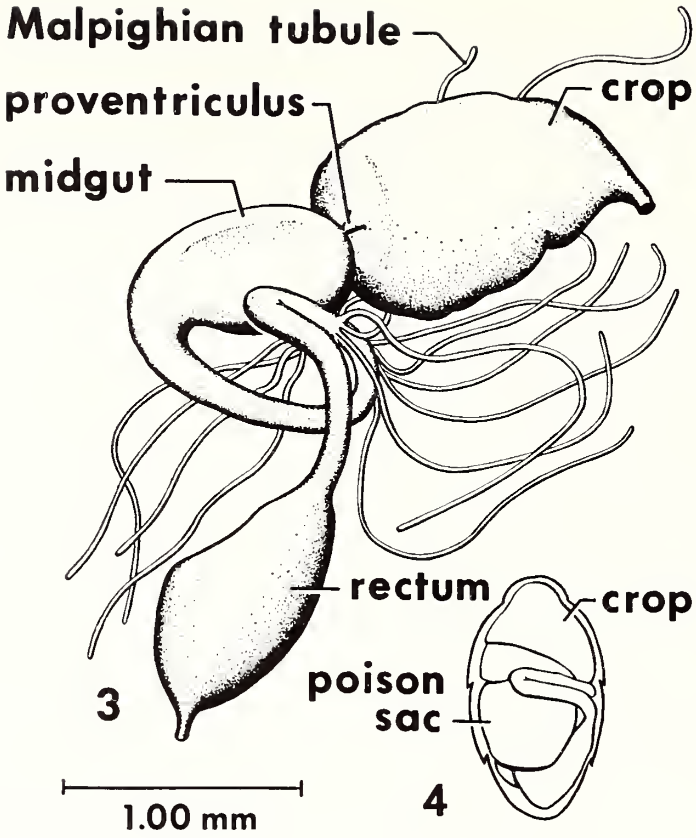
Since little else is known of the biology and behavior of *C. morosus,* it must be assumed that its foraging and emigrating activities resemble those of *C. megalonyx,* for which Wheeler (1921) provided a brief description. His observations indicated that *C. megalonyx* is strongly photophobic. One colony was discovered beneath a pile of logs, and emigrated after being disturbed. Its columns moved beneath leaves, sticks, and boards, where such cover was available. Open spaces were crossed through galleries about four-fifths of an inch wide, which the workers constructed of "small particles of earth." This behavior strongly suggests a hypogaeic lifeway.

MAJOR WORKER MORPHOLOGY: With the exception of descriptive external observations and the work of Hermann and Blum (1967), Hermann (1969), and Gotwald (1969), the morphology of *C. morosus* has not been previously studied. The gross anatomy of portions of the digestive and reproductive systems and of the poison apparatus was studied in this investigation. The structures examined are those considered of potential value in understanding the relationship of this ant to other New World dorylines.

The worker caste of *C. morosus* is described as strongly dimorphic by Emery (1910) and Borgmeier (1955) and is commonly separated into workers and soldiers. Emery (1910) noted, however, that there is a gradual transition between the two groups. The mandibles and overall size form the basis for the distinction between workers and soldiers. The mandible of the soldier is cylindrical and falcate with 1 apical and 2 subapical teeth, while that of the worker is flattened, somewhat triangular, with 1 apical and 2 subapical teeth and a series of denticles. The specimens examined and reported on in this investigation belong to the soldier caste unless otherwise noted. Where possible, the morphology of *C. morosus* is specifically compared to that of other New World Dorylinae.

GASTRAL DIGESTIVE TRACT: (Figs. 3 and 4). The expansible crop is connected to the midgut by means of a membranous proventriculus and occupies a major portion of the first gastral segment. The crop was distended in all specimens examined. The proventriculus closely resembles that of *Eciton hamatum* (Fabricius), which Eisner (1957) described as degenerative. It appears to be reduced to a simple stomodaeal valve with the bulbar cuticle irregularly folded. Eisner (1957) speculated that this type of proventriculus permitted the passage of solid matter through the bulb under muscular pressure.

The midgut is flattened, ellipsoid, shares the first gastral segment with the crop, and usually occupies a transverse position in the gaster. Posteriorly the midgut narrows to form a cylindrical tube anterior to the insertion of the Malpighian tubules. The midgut of the workers of *Eciton hamatum* and *burchelli* (Westwood) are described as pear-shaped (Whelden, 1963a) but lack the well developed tubular, pre-Malpighian tubule tract of *C. morosus.*



Figs. 3–4. Gastral digestive system of *C. morosus* soldier. Fig. 3. Digestive tract removed from gaster. Fig. 4. Digestive tract *in situ,* dorsal view (drawing not scaled).

Malpighian tubule counts were made on a series of workers. Ettershank and Brown (1964) emphasized the possible value of the tubules as meristic characters in the ants. With this in mind, counts were made in six other species of New World dorylines, during and subsequent to the 1965 field expedition. The results of these counts are summarized in Table 1. Although there is considerable overlap in tubule number range, the mean numbers of tubules are distinct for several species. It appears, however, that the number of tubules is less species specific than it is a function of body size. Indeed, Gray and Lamb (1968) statistically demonstrated a positive correlation between tubule number and head width in *Myrmecia dispar.* It might thus be assumed that the number of tubules is directly correlated with the volume of the individual's hemocoel or at least with overall body size. This appears to be true not only intraspecifically but interspecifically as well. Contrast the mean tubule number for the relatively large ant *L. coecus,* for example, with the mean figure for the smaller *N. nigrescens* (Cresson) (Table 1).

The intestine begins posterior to the insertion of the Malpighian tubules. It continues the alimentary canal as a cylindrical tube. This tube expands to form a thin-walled rectum similar to that of *E. hamatum* and *burchelli* (Whelden, 1963a). Two flattened and elliptical rectal papillae or glands are found in the anterior third of the rectum, one on each side of the opening of the intestine.

Table 1. Malpighian tubule counts in 7 species of New World Dorylinae.

Species		No. Specimens Dissected	Range	Mean	Range for All Workers	Mean for All Workers
Cheliomyrmex morosus (F. Smith)	Soldier	5	11–15	13.20	8–15	11.67
	Media Worker	5	10–15	12.60		
	Minor Worker	5	8–10	9.20		
	Male	1	50	50.00		
Eciton mexicanum Roger	Soldier	1	23	23.00	14–23	19.25
	Media Worker	1	23	23.00		
	Minor Worker	2	14–17	15.50		
Labidus coecus (Latreille)	Soldier	5	15–17	15.80	7–17	10.89
	Media Worker	7	9–12	10.86		
	Minor Worker	7	7– 9	7.43		
Labidus praedator (F. Smith)	Soldier	1	20	20.00	12–20	14.75
	Media Worker	1	15	15.00		
	Minor Worker	2	12	12.00		
Neivamyrmex nigrescens (Cresson)	Major Worker	5	7– 8	7.60	4– 8	6.07
	Media Worker	5	4– 8	5.60		
	Minor Worker	5	5	5.00		
Neivamyrmex opacithorax (Emery)	Media Worker	1	6	6.00	5– 6	5.50
	Minor Worker	1	5	5.00		
Neivamyrmex pilosus (F. Smith)	Major Worker	5	9–12	11.00	6–12	8.31
	Media Worker	6	7– 9	8.17		
	Minor Worker	8	6– 9	6.75		

Whelden (1963a) reported usually three and rarely six rectal papillae in the workers of *E. hamatum* and *burchelli.*

REPRODUCTIVE SYSTEM: (Figs. 5 and 6) Ovaries were found in 4 soldiers. Each ovary consists of a single, polytrophic ovariole. In the polytrophic ovariole, the developing oocytes are separated by groups of trophocytes or nurse cells from which the oocytes receive nutrient molecules. Difficulty was encountered in removing the ovaries from the *C. morosus* soldiers, and in each case, the terminal filaments and portions of the germaria were lost because of their entanglement with surrounding tissues. In most cases the follicular epithelium was clearly evident around each oocyte.

Whelden (1963b) described the reproductive system of workers of *E. hamatum* and *burchelli* as simple in structure and unlike that of the queens. He found as many as 3 ovarioles in each ovary, but in many minor workers, only one per ovary was found, thus appearing similar to *C. morosus.* To contrast the worker and queen ovaries, it should be noted that Hagan (1954) found each ovary of the queen of *E. burchelli* to contain at least 1200 ovarioles.

In the *C. morosus* soldier, the ovaries and common oviduct are ventral to the ducts of the poison sac and Dufour's gland in the terminal segments of the gaster

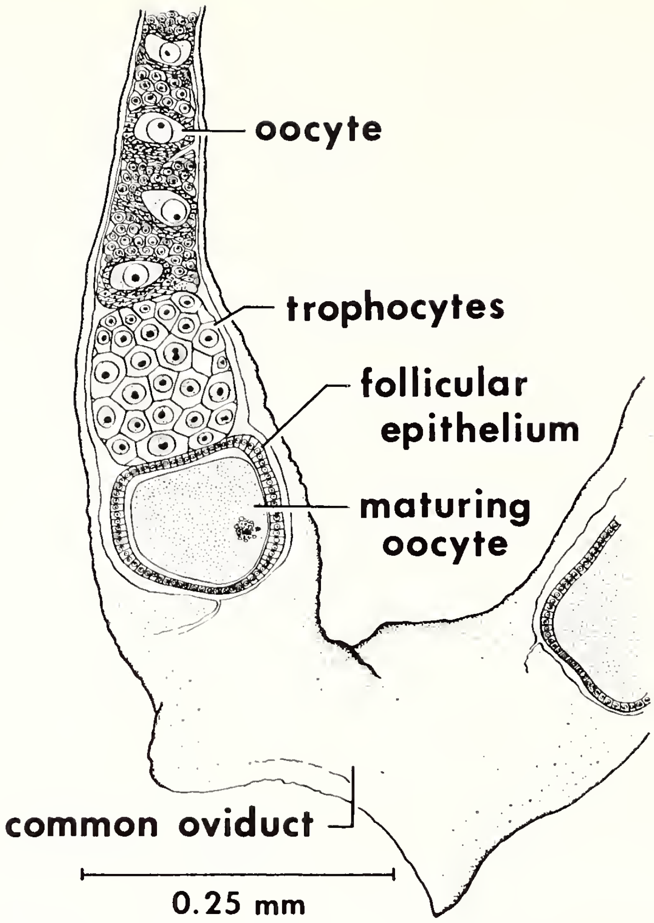


Fig. 5. Right ovary of *C. morosus* soldier, ventral view, terminal filament not shown, portions of drawing diagrammatic.

(Fig. 6). Several oocytes can be seen in each ovariole, and in each case, the oocyte closest to the common oviduct is in an advanced stage of growth and maturation (Fig. 5). Usually the nucleus is not discernable in these latter cells. The trophocytes are polyhedral cells.

POISON APPARATUS: (Figs. 6 and 7) Although the entire sting apparatus was examined, only the glandular elements are reported on here. The poison sclerites have been discussed and illustrated by Hermann (1969). The poison sac is the most conspicuous structure in the gaster and is situated between the midgut and rectum. The sequential order of major gastral organs along the longitudinal axis is constant (see Fig. 4). Some positional variation, however, is encountered in the skewing of the organs to the right or left.

The poison sac is generally spherical with its conspicuous duct ending in the sting bulb (Fig. 7), and is similar to the poison sac of *Eciton hamatum* (Whelden, 1963a; Hermann and Blum, 1967). The posterior face of the sac usually bears a concave impression probably created by pressure from the rectum. This often gives the sac a much more cylindrical appearance.

The free poison filaments (Figs. 6 and 7) arise from the poison sac duct, and their origin is similar to that found by Hermann and Blum (1967) in *E. hamatum* [although Whelden (1963a) reported that the filaments arose from the anterior

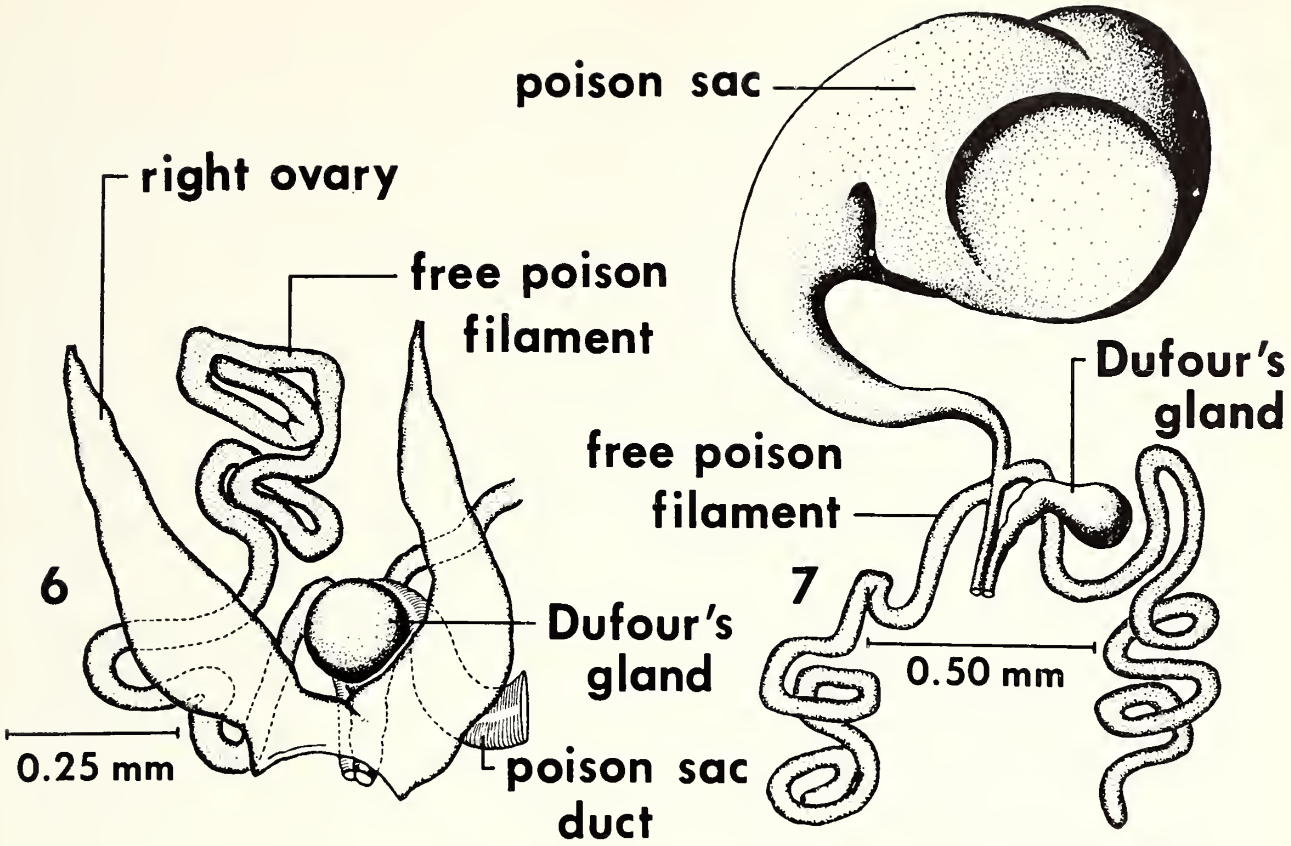


Fig. 6. Ovaries and portions of poison apparatus of *C. morosus* soldier, ventral view. Fig. 7. Glandular elements of poison apparatus of *C. morosus* soldier.

end of the sac in this species]. The filaments appear to arise much farther down the duct from the poison sac in *C. morosus* than they do in *E. hamatum.* These ribbon-like filaments are unbranched and appear to be randomly distributed within the vicinity of the poison sac.

The Dufour's gland is spheroid, sac-like, and much smaller than the poison sac. This gland is situated at the apex of the joining ovarioles (Fig. 6). As in *E. hamatum* (Hermann and Blum, 1967), its duct enters the sting bulb ventrad to the duct from the poison sac.

Hermann and Blum (1967) have examined the sting apparatus, especially the skeletal components, of *Cheliomyrmex* and report that this genus lacks the furcula, a sclerite absent in all dorylines. Hermann (1969) has recently provided a more detailed examination of the poison sclerites.

DISCUSSION

Preliminary evidence suggests that *C. morosus* and *megalonyx* are hypogaeic, i.e., they maintain subterranean bivouacs and forage either beneath the surface of the soil and/or on the surface of the soil beneath debris. When such debris is absent the workers (*C. megalonyx*) fashion surface galleries of soil particles, thus avoiding exposure to the light or perhaps other factors. Similar hypogaeic behavior patterns, including the construction of surface galleries, also occur in the New World doryline, *Labidus coecus* (Borgmeier, 1955). *Labidus praedator* (F. Smith), on the other hand, is intermediate between the hypogaeic *coecus* and the epigaeic ecitonines such as *Eciton hamatum.* Wheeler (1921) reported that while *L. praedator* constructs surface galleries, it does, on occasion, forage in the open on the soil surface. I have also observed a column of *L. praedator* crossing a path, in the open, without constructing galleries (Mexico, 1965). A range of behavior patterns, then, exists in the New World Dorylinae, and it is not unusual to see behavioral variation within a single genus (e.g., *Labidus*). Of the Old World Dorylinae, species of the genus *Dorylus* are primarily hypogaeic (Wheeler, 1922). The subgenus *Anomma,* however, contrasts sharply with other *Dorylus* subgenera, being strongly epigaeic in its foraging habits (Wheeler, 1922; Raignier and van Boven, 1955). *Aenictus* likewise contains both hypogaeic and epigaeic forms (Schneirla and Reyes, 1966).

The intrageneric variation in bivouac formation and foraging patterns suggests that the nature of these phenomena (i.e., whether they are hypogaeic or epigaeic) is not particularly helpful in establishing phylogenetic relationships within the Dorylinae.

Hypogaeic conditions, however, may significantly affect other generic-specific behavior patterns. Schneirla (1957, 1964) suggested that variable nomadism (as opposed to regular nomadic-statary cycles) is correlated, in part, with communicative processes as they occur in diffuse subterranean bivouacs (in *Dorylus, Anomma, Labidus,* and *Nomamyrmex*). Again, variable nomadism occurs in both New and Old World genera, and it may be presumed that *Cheliomyrmex,* as a hypogaeic form, exhibits variable nomadism, a condition of group predatory behavior (see Wilson, 1958).

The structure of the cheliomyrmecine pedicel is of particular interest since it consists of a single node (i.e., the postpetiole is not separated from the 4th abdominal segment by a constriction), whereas the remaining New World dorylines (the tribe Ecitonini) are binodally pedicellate. Phylogenetically this condition may be viewed in two ways: (1) it may be considered an extremely important morphological discontinuity within the New World Dorylinae, or (2) it may be regarded as a relatively unimportant development, attributable to the lability of the abdomen. The structure of the pedicel in other subfamilies appears conservative. It is, for instance, uninodal throughout the Dolichoderinae and Formicinae and binodal in the Pseudomyrmicinae and Myrmicinae. Brown (1954a) placed these latter two groups in two different formicid complexes and considered the binodal pedicellate condition in each subfamily to be evolutionarily convergent. The condition of the pedicel is least conservative in the Dorylinae, as it is presently constituted, with the binodal condition in the Ecitonini and Aenictini, and the uninodal condition in the Cheliomyrmecini and Dorylini. Considering the evidence of Reid (1941), Hermann (1969), and Gotwald (1969), *Cheliomyrmex* is phylogenetically closer to the Ecitonini than is suggested solely by the condition of the pedicel.

The proventriculus in *Cheliomyrmex* is predictably reduced and consists only of a stomodeal valve. It is like the proventriculus of *E. hamatum* (Eisner, 1957). The proventriculus of other dorylines has not been thoroughly examined and comparison to *C. morosus* is impossible. Mukerjee (1933) provided a brief description of the proventriculus of *Dorylus* (*Alaopone*) *orientalis* Westwood, indicating that "the longitudinal folds or ridges projecting within its lumen are ill-developed." This description applies equally well to the cheliomyrmecine proventriculus.

The presence of ovaries containing maturing ova in *C. morosus* workers suggests that these workers lay unfertilized eggs. Egg laying in many ant species, of course, is not confined to the queen, and worker eggs, although in most cases not reared, are used as larval food (Wallis, 1965). Also, Weyer (1927) reported that maturing ova in two species of Formicinae are reabsorbed. Ovaries were not found in all workers of *C. morosus* dissected, nor are they always found in all individuals of other species involving ovary-bearing workers. Mukerjee (1927) in a study of *Myrmicaria brunnea* Saunders, found ovaries in only four specimens of nearly 100 examined. In addition to Whelden's (1963b) description of worker ovaries in *Eciton,* Mukerjee (1933) provided a description of the worker ovary in *Dorylus* (*A.*) *orientalis.* Structural and histological variation between doryline worker ovaries is minimal, except for the number of ovarioles making up a single ovary.

It is the function of such ovaries that stimulates the most intriguing questions. In some species of *Rhytidoponera*, *Diacama*, and *Leptogenys*, queens are not known and the queen function is assumed by workers (Brown, 1954b; Brown and Taylor, 1970). The frequency and function of egg laying (if it occurs at all) in the workers of *C. morosus*, however, can only be speculated upon, and precise answers clearly await discovery of the queen and exacting studies of colony behavior.

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BYLAWS OF THE NEW YORK ENTOMOLOGICAL SOCIETY

Revision date: December 7, 1965.[1]
Organized June 29, 1892
Incorporated June 7, 1893
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Article I

Members

All persons interested in entomology shall be eligible for membership. Members in all categories except Student shall be entitled to vote and hold office. Categories of membership shall be:

1. Active members. Members who elect to pay annual dues of Four Dollars ($4.00).
2. Sustaining members. Members who elect to contribute to the support of the Society by paying annual dues of Twenty-five Dollars ($25.00).
3. Student members. Members who elect to pay annual dues of Two Dollars ($2.00) and who are either under 21 years of age or are currently enrolled in a course of study leading to a degree in some biological science.
4. Life members. Members who have purchased life membership by paying the sum of One Hundred and Seventy-five Dollars ($175.00) at any one time in lieu of further annual dues. Life members shall be no less than 45 years of age.
5. Honorary members. Eminent entomologists elected to honorary membership in recognition of their service to science. There shall be no more than twelve (12) honorary members at any one time.

Article II

Election of Members

All candidates for membership must be proposed by a member of the Society at a regular or annual meeting. They shall be voted upon individually at the following meeting, and the affirmative vote of at least two-thirds of the members present (given by voice, or by ballot if demanded) is required for election.

Article III

Officers and Committees

1. Elective officers of the Society shall consist of a President, a Vice President, a Secretary, an Assistant Secretary, a Treasurer, an Assistant Treasurer, and four Trustees.

2. The Society shall be governed by an Executive Committee, composed of the President (Chairman), the four Trustees, the Vice President, the Secretary, the Assistant Secretary, the Treasurer, the Assistant Treasurer, the Chairman of the Publications Committee, the Editors, and the Publications Business Manager, all of whom are entitled to vote except the Assistant Secretary, Assistant Treasurer, Editors, and Publications Business Manager.

3. There shall be an elective Publications Committee composed of three members who shall elect their own chairman. Editors and Associate Editors shall be ineligible for membership on the Publications Committee.

4. The President, after consultation with the Publications Committee, and with the

advice and consent of the Executive Committee, shall appoint Editor(s) and Associate Editor(s) for each publication of the Society. He shall also appoint a Publications Business Manager.

5. Standing Committees of the Society, to be appointed by the President, shall consist of an Auditing Committee composed of three members; a program Committee composed of two members; and a Field Committee composed of two members and the Director of the Junior Entomological Society who shall be a member ex-officio without vote. One member of the Program Committee shall be designated by the President as Program Chairman.

6. Temporary committees may be appointed by the President at his discretion to perform special duties which he shall define. The President also shall appoint a Nominating Committee, consisting of three members, to nominate a full slate of officers and a Publications Committee at the annual meeting.

Article IV

Election of Officers and Committees

1. Officers and members of elective committees shall be elected at the annual meeting of the Society by a majority vote of the members present or voting by proxy.

2. Trustees shall be elected for a two-year term, two being elected each year. A member who has served for two consecutive terms as trustee shall be ineligible for reelection as trustee for one year after completion of his term of office. If the office of a trustee shall become vacant before the expiration of his term the vacancy may be filled by appointment by the President, but the fraction of the term shall be counted as a full term in determining eligibility for election or reelection.

3. All other officers and members of the Publications Committee shall hold office for one year, or until the next annual election.

4. Any vacancy that may occur among the officers or the Publications Committee, except as elsewhere herein provided, shall be filled by appointment by the Executive Committee. The person appointed to fill the vacancy shall hold office until the next annual meeting.

Article V

Duties of Officers and Committees

1. The President shall preside at all meetings. He shall appoint all committees except the Executive Committee and the Publications Committee, and shall make such other appointments as are elsewhere herein provided; he shall be chairman of the Executive Committee and a member ex-officio, without vote, of all other committees.

2. The Vice President shall assume the duties of the President in case of the death, resignation, absence, or disability of the President. In case both the President and Vice President are absent at a meeting, a temporary chairman may be chosen by the members present to preside at the meeting.

3. The Secretary shall keep the minutes of the meetings of the Society for publication in the *Journal*, and shall keep the minutes of the Executive Committee. He shall give notice of the meetings of the Society when not otherwise herein provided for; advise members, in writing, of their election and send their names to the Treasurer; keep all records and files of the Society and generally perform such services as may be delegated to him by the Society. At the expiration of his term of office the Secretary shall deliver to his successor all papers, books, and other records belonging to the Society.

4. The Assistant Secretary shall act in case of the death, resignation, absence, or disability of the Secretary and shall assist the Secretary as need be.

5. The Treasurer shall receive all moneys for the Society and deposit them in the name

of the Society in such banking institutions as the Executive Committee may direct; he shall pay there-from by draft or check all bills and obligations not exceeding Twenty-five Dollars ($25) and all others when approved by the President or Editor(s). He shall keep an account of all monetary transactions and shall exhibit a statement of them when called for by the President, Editor, Executive Committee, or Auditing Committee, and shall make a full report for the preceding calendar year at the annual meeting. He shall notify members respecting payment of dues within ten days after their election and thereafter when annual dues become payable, and shall send out membership cards on receipt to dues. At the expiration of his term of office, the Treasurer shall deliver to his successor all funds, papers, books, and vouchers belonging to the Society.

6. The Assistant Treasurer shall act in case of the death, resignation, absence, or disability of the Treasurer and shall assist the Treasurer as need be.

7. An Editor shall have general charge, management, and supervision of the publication to which he has been appointed.

8. An Associate Editor shall assist the Editor as need be.

9. The Publications Business Manager shall conduct the business affairs of the Society's publications.

10. The Executive Committee shall meet at the call of the President. It is empowered to call for a report from any of the officers or committees of the Society at its discretion. It shall keep minutes of its proceedings which shall be available to any member of the Society and which may be read to the Society upon request. It shall have general charge of the funds, investments, and property of the Society. It shall decide on the status of members in arrears of dues. With the advice of the Publications Committee it shall determine the subscription price of all publications and discounts allowed in connection with their sale. The Executive Committee shall be the only policy-making organ of the Society.

11. The Publications Committee shall make recommendations to the Executive Committee regarding policies relating to publications and shall assist the Editor, or Editors, in carrying out the policies established by the Executive Committee.

12. The Auditing Committee shall examine the accounts and reports of the Treasurer and shall report to the Society thereon at the annual meeting or at some date specified by the President.

13. The Program Committee shall plan and arrange for the programs of the meetings.

14. The Field Committee shall arrange for and manage the excursions and outings of the Society, and shall assist the Director of the Junior Entomological Society.

Article VI

Publication Funds

All funds subscribed or donated for the *Journal* or other publications of the Society shall be used for no other purpose than those specified.

Article VII

Dues

1. Dues for active membership shall be Four Dollars ($4) per annum.
2. Dues for sustaining membership shall be Twenty-five Dollars ($25) per annum.
3. Dues for student membership shall be Two Dollars ($2) per annum.

Payment of Dues

All dues are payable in advance on the first day of January of each year. New members, if elected on or after October 1, shall pay no dues for the year of their election.

Honorary members shall be exempt from the payment of dues.

Article VIII

Members in Arrears

All members in arrears in the payment of dues for one year are subject to the loss of the privilege of voting or holding office. Before the annual meeting the Treasurer shall present a list of the members in arrears in the payment of dues to the Executive Committee, which shall decide upon appropriate action.

Article IX

Subscription to Publications

1. The subscription price of all publications, the price of single numbers to active members, student members and non-members, as well as the price of sets, shall be determined by the Executive Committee on the recommendation of the Publications Committee.
2. Subscriptions shall be payable in advance of the first of January of each year.
3. The *Journal* shall be sent gratis to all Sustaining and Life members.
4. All publications of the Society shall be sent gratis to all Honorary members.

Article X

Meetings

1. Regular meetings of the Society shall be held at The American Museum of Natural History (or at such other place as the membership shall determine) on the first and third Tuesdays of each month at 8:00 P.M. No regular meetings will be held during the months of June through September or upon a legal holiday or upon the first Tuesday of January.
2. The annual meeting of the Society shall be held at The American Museum of Natural History (or at such other place as the membership shall determine) on the first Tuesday in January of each year at 8:00 P.M., if not a legal holiday, otherwise on the third Tuesday.
3. Special meetings of the Society may be called by the Secretary upon a written request of the President or 10 active members. Such a request shall state the purpose for which the meeting is to be called. The Secretary shall notify the membership of such a meeting, stating its purpose and the time and place at which it is to be held. No other business except that specified in the call shall be transacted.
4. Eleven (11) members shall constitute a quorum for the transaction of business.
5. At any special meeting members in good standing may vote or be represented by proxy.
6. Whenever notice of any meeting is required by the bylaws, it shall be deemed sufficient if given by postal card and addressed to each member of the Society at his last known postal address at least ten (10) days and not more than twenty (20) days before the meeting, or if given as required by the General Corporation Law of the State of New York. If the need for a special meeting, under the provisions of Sec. 3 of this Article, be deemed an emergency by the President or Secretary, the membership may be notified by any practicable means.

Article XI

The Order of Business

The order of business of regular meetings shall be as follows:

1. Reading of minutes.
2. Reports of officers.
3. Reports of committees.
4. Election of members.
5. Proposals for membership.

6. Miscellaneous business.
7. New business.
8. Reading of papers and scientific discussion.
9. Adjournment.

The order of business of the annual meeting shall be as follows:

1. Reading of minutes.
2. Roll call, verification of proxies.
3. Annual reports of officers.
4. Reports of committees.
5. Election of officers and elective committees.
6. Miscellaneous business.
7. Proposals and elections for membership.
8. Reading of papers and scientific discussion.
9. Adjournment.

The order of business may be changed or suspended at any meeting with consent of two-thirds or more of the members present.

Article XII

Auxiliary Organizations

1. The Society shall sponsor an auxiliary organization to be known as The Junior Entomological Society having its own officers and constitution. It shall be organized solely for educational and scientific purposes and shall conform to the requirements set forth in Article XIII.

2. The Junior Entomological Society shall be under the direction of an active member of the New York Entomological Society, appointed to that capacity by the President and responsible to the Executive of Committee. He shall be known as The Director of the Junior Entomological Society. He shall be a member ex-officio, without vote, of the Field Committee.

Article XIII

General Prohibitions

1. The Society shall be organized and operated for scientific and educational purposes. No part of the receipts of the Society shall, under any circumstances, inure to the benefit of any private individual.

2. No substantial part of the activities of the Society shall consist of carrying on propaganda, or otherwise attempting to influence legislation. The Society shall not participate in, or intervene in any political campaign on behalf of any candidate for public office; nor shall it publish or distribute statements on behalf of such candidates.

3. The Society shall not be organized or operated for a profit.

4. The Society shall not transact any business with any officer or member of the Society or any substantial contributor to the Society which shall result in gain to that individual (or corporate body) which shall represent more than a proper consideration for services rendered or goods or material sold to the Society.

Article XIV

Distribution on Dissolution

In the event of the dissolution of the Society and after payment of all expenses and liabilities, all assets remaining will be transferred to an entomological organization to be chosen by the Society which shall have been organized for scientific and educational purposes within the meaning of Section 501 (c) (3) of the Internal Revenue Code of 1954.

Article XV

Amendments

These bylaws may be amended at any regular meeting, or at a special meeting of the Society called for that purpose, by the vote of two-thirds or more of the members present, provided that the proposed amendment or amendments shall have been approved by the Executive Committee, submitted in writing to all members by mail at least thirty days in advance, and presented at a previous meeting of the Society, due notice thereof having been given in conformity with the previsions of Article X.

Date of revision: December 15, 1970

BOOK REVIEW

The Moths of America, North of Mexico, including Greenland. Fascicle 21, Sphingoidea. Ronald W. Hodges. E. W. Classey, Ltd. and R. B. D. Publications, Inc., London, 1971. 158 + vi pp., 14 color plates, 155 figs., photographs. $24.00 (£10 sterling).

This is the first part to be published of a series that is planned to comprise 41 fascicles and to cover completely all of the moths of North America. The various parts will be prepared by a number of the leading lepidopterists of the United States and Canada. This fascicle is representative of those that will follow. It is dual in nature, being authoritatively scientific and revisional and also "popular," perfectly suitable for the use of the untrained amateur, collector and naturalist. The extremely fine and complete illustrations contribute greatly to both of these features: the drawings of genitalia and other structures are particularly important taxonomically, while the color photographs of adults will enable nearly anybody to identify species almost offhand.

A complete outline of the classification is given, and all categories from family to species are fully characterized. Original keys are given to the genera and to the species of each genus, based on the adults. Similar keys to the pupae and larvae are modified from Mosher and Forbes respectively. Under each genus is a discussion of its synonymy, general extent and geographic distribution, and a condensed listing of the chief adult, pupal and larval characteristics. The same features are given for each species. Type genera, type species and type localities are cited fully. Particularly important are the detailed descriptions of individual and geographic varation, since the author places in synonymy a great many names that have been used as subspecies or even valid species. Under each species are also given lists of food plants, summarizations of the geographic distribution and other useful data. The synonymies give the original bibliographic references of all names, and the bibliography includes the chief publications on the group. A few new generic and specific names and new combinations are proposed.

Many very excellent line drawings show the chief structural characteristics used in the classification. Those of the male and female genitalia are particularly important, since no consistent studies of these structures have ever been made, and the author bases his classification on them very largely. The 14 photographic color plates show 199 specimens, X1, well illustrating the range of variation found in many of the species. It is difficult to keep from piling up superlatives about these plates, which reflect the great care, patience and skill of both the photographers and the publishers. This reviewer cannot think of any that surpass them. A very useful feature, which should be adopted by other authors and publishers, is the cross referencing of each illustration to its appropriate text page. This will save users of the publication an inordinate amount of fumbling and page-turning.

Without doubt everyone interested in North American moths, or in Sphingidae from anywhere, will wish to obtain a copy of his work and, doubtless, of many of the fascicles that are to follow. It, and a brochure about the series may be obtained from: Entomological Reprint Specialists, P. O. Box 77971, Dockweiler Station, Los Angeles, California, 90007.

ALEXANDER B. KLOTS
The American Museum of Natural History

JOURNAL of the NEW YORK ENTOMOLOGICAL SOCIETY

The JOURNAL of the NEW YORK ENTOMOLOGICAL SOCIETY is devoted to the advancement and dissemination of knowledge pertaining to insects and their related forms.

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2. FORM OF MANUSCRIPT. Text, footnotes and legends must be typewritten, double or triple spaced, with margins of at least 1½ inches on all sides. The editorial style of the JOURNAL essentially follows the *Style Manual for Biological Journals* (2nd edition, A.I.B.S., 1964).

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Biochemical abbreviations: follow rules of the U.I.P.A.C. -I.U.B.
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Journal
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New York Entomological Society

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Incorporated May 21, 1968

The New York Entomological Society

Organized June 29, 1892—Incorporated February 25, 1893
Reincorporated February 17, 1943

The Brooklyn Entomological Society

Founded in 1872—Incorporated in 1885
Reincorporated February 10, 1936

The meetings of the Society are held on the first and third Tuesday of each month (except June, July, August and September) at 8 P.M., in the AMERICAN MUSEUM OF NATURAL HISTORY, 79th St. & Central Park W., New York, N. Y. 10024.

Annual dues for Active Members, $4.00; including subscription to the Journal, $9.00.

Members of the Society will please remit their annual dues, payable in January, to the Treasurer.

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Mailed April 27, 1972

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Ultrasonic Vibration Effects on the Development and Respiratory Metabolism of the Egg of *Tenebrio molitor* Linn. (Coleoptera: Tenebrionidae)[1]

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Department of Biological Sciences,
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Received for Publication June 25, 1971

Abstract: When eggs of the mealworm, *Tenebrio molitor*, were allowed to develop at 30° C., 85.1% of them hatched. Treatment of eggs at different stages of development with ultrasonic vibrations of 20 kilocycles per second for 15 seconds at 10, 20, and 30 watts resulted in values ranging from 1.8 to 46.8%. Earlier stages were more sensitive than the later ones. Correspondingly, the rate of oxygen consumption was reduced more during early development than at later stages. There was a significant decrease during the first four days, whereas during the last two days the decreases were not significant. These effects may be correlated with the embryological events occurring within the eggs at the time of their treatment and with the structure of the egg membrane.

Ultrasonic waves (high-frequency sound waves above the upper limit of human hearing) have been found to influence development in a variety of ways, ranging from no effect to those which are lethal. Effects include acceleration of development, parthenogenetic stimulation of development, acceleration of metabolism, an increase in growth and size, inhibition of growth, depressed development, reduction in size, delayed maturation, modification in the percentage of survival, abnormalities, and mutations.

Treatment of eggs of wild type *Drosophila virilis* with ultrasonic vibrations of 450 kilocycles per second (kc./sec.) by Takebe (1944) resulted in 22% "vestigial"-winged individuals that were shown to be a phenocopy. Fritz-Niggli and Böni (1950) and Fritz-Niggli (1951) treated eggs of a wild stock of *D. melanogaster* with vibrations of varying intensities from 0.3 to 4.0 watts/cm^2 and found that the radiation produced a delayed reaction, with death sometimes occurring in later stages. When the adults derived from treated eggs were examined, damage was found but no lethal mutations were noted. Counce and Selman (1955) reported different types of abnormalities in embryonic development after treatment of eggs of *D. melanogaster* with low intensity vibrations of 1000 kc./sec. for 30 seconds. Sautet, Levavasseur, and Vuillet (1947) exposed eggs of mosquitoes to vibrations of 960 kc./sec. and observed that the eggs of *Anopheles maculipennis* and *Culex pipiens* were more sensitive to ultrasound than those of *Aedes mariae*. At high intensities, for a 30 second exposure, eggs burst readily, while at low intensities there was no destruction, but a stimulation and acceleration of hatching. Eggs of the yellow-fever mosquito, *Aedes aegypti*, treated for 15, 20, 25, and 30 seconds with waves of 500 kc./sec. by Quraishi, Osmani, and Ahmad (1963) showed percentages of hatching of 71.2, 68, 64.6, and 55, respectively, as compared with 62.5 in the control. Getsova, Lapinskaia, and Khenokh (1958) observed that exposure of the eggs of the Shantung silkworm, *Antheraea pernyi*, to vibrations of 125 kc./sec. at 300 to 400 watts for 1 to 30 minutes, at different periods from the beginning of development through formation of the "primitive groove" had a stimulating effect and increased the embryonic development rate. Subjection of the egg to ultrasound during the stage of blastokinesis, when the embryo is already formed, had no stimulating effect, and led to the death of the embryo.

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[1] From a dissertation submitted by the senior author in partial fulfillment of the requirements for the degree of Doctor of Philosophy in the Department of Biological Sciences at Fordham University. These experiments were supported in part by a National Science Foundation Science Faculty Fellowship.

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[3] Professor Ludwig died on February 6, 1970.

The effects of ultrasound on *Tenebrio molitor* have been investigated on larvae and pupae. Frings, Allen and Rudnick (1948) found that the larvae were killed in 30 seconds when exposed to high-intensity air-borne ultrasonic waves of 18.5–19.0 kc./sec. Kocian (1936) observed that short exposures of 30 seconds, and 1 minute to a high-frequency electric field had no effect on respiration or metamorphosis of pupae, but exposures of 5–10 minutes shortened the pupal period and lowered oxygen consumption. Kadoum, Nelson, and Stetson (1967) found that the mortality of larvae exposed to radiofrequency electric fields of 39,000 kc./sec. increased with exposure time and intensity. Kadoum, Ball, and Nelson (1967) observed that adults developing from larvae exposed at sublethal levels to this same frequency had malformed and missing legs. Kadoum, Ball, and Stetson (1967) reported that when larvae were briefly treated under the same conditions, a progressive loss of body weight occurred during the ensuing week. Younger larvae lost proportionately more weight than older ones. The present investigation was conducted to obtain information about the response of the egg of *Tenebrio molitor* to vibrations of 20 kc./sec. and the influence of ultrasound on the physiology of development.

MATERIALS AND METHODS

Pupae of the mealworm, *Tenebrio molitor*, were collected from our laboratory stock cultures, placed in culture dishes and kept in an incubator at 30° C. Newly emerged adults were transferred to culture dishes containing chick growing mash and kept at 30° C. for the preoviposition period of four days. Moisture was supplied by cloth covers to which tap water was added several times a week. To eliminate any possible parental age effects, as found by Ludwig and Barsa (1955), Ludwig (1956), Tracey (1958), Ludwig and Fiore (1960, 1961), and

Ludwig, Fiore and Jones (1962), only mature young adults of 2 to 4 weeks were used in these experiments. For egg collection, they were placed in culture dishes containing white flour. A vial of water with a moist cotton plug in each culture dish was the water source. Eggs were collected each day by sifting the flour. They were kept in dated vials and placed in a desiccator, the base of which contained a saturated solution of NaCl (relative humidity 75%) and incubated at 30° C. The age of each egg was known to within 24 hours.

Eggs for each day of embryonic development at 30° C. from the day of collection (0 day) to just before hatching (5 day) were used to study the effects of ultrasonic vibrations on the percentage of hatching and the rate of oxygen consumption.

The Bronwill-Blackstone Biosonik Needle Probe was used as the source of ultrasonic vibrations. Groups of 50 eggs for each day of embryonic development were weighed and placed in 18 ml. shell vials. Immediately before treatment, 7 ml. of distilled water was added to the eggs in the vial, after which the tip of the vibrating needle probe was lowered 7 mm. into the distilled water.

Preliminary experiments were run for periods of 15, 30, 45, and 60 seconds, with vibrations of 20 kc./sec. at a power setting of 10 watts to determine the optimal time of treatment. As a result, 15 seconds was chosen as a sublethal dose and eggs were treated for 15 seconds at power settings of 10, 20, and 30 watts (approximate intensities of 0.178 watts/cm^2, 0.356 watts/cm^2, and 0.534 watts/cm^2, respectively). The temperature of the distilled water was checked during treatment. Since ultrasonic treatment was limited to short periods of time, the experimental temperature remained below 30° C. The treated eggs were removed immediately from the distilled water, blotted dry with filter paper, placed in stender dishes, and incubated at 30° C. Control groups were run under the same conditions without ultrasonic treatment. The duration of the egg stage and the percentage of hatching of both groups (treated and control) were determined and compared.

To study the effect of ultrasonic vibrations on the respiratory metabolism of the egg, measurements of oxygen consumption were made on both control and treated eggs in groups of 50 at ages of 0, 1, 2, 3, 4, and 5 days. Bronwill Differential Respirometers were used at 30° C. following the procedure outlined by Umbreit, Burris and Stauffer (1957).

OBSERVATIONS

The percentage of hatching in 700 untreated eggs averaged 85.1%. In treated eggs, as shown in Table 1, it ranged from 1.8 to 46.8% regardless of the intensities used. Resistance to ultrasonic vibrations increased with the age of the egg at the time of treatment.

No observable change in the time of hatching was noted for eggs treated with ultrasonic vibrations when compared with normal eggs. Treated eggs allowed

Table 1. Percentages of hatching of ultrasonicated eggs of the mealworm, *T. molitor*, treated during embryonic development for 15 seconds with ultrasonic vibrations of 20 kilocycles per second at power settings of 10 watts, 20 watts, and 30 watts.

Age of eggs	Number of eggs used	% hatched with 20 kc./sec. 15 sec., 10 watts	% hatched with 20 kc./sec. 15 sec., 20 watts	% hatched with 20 kc./sec. 15 sec., 30 watts
0 day	1550	1.8	1.8	1.8
1 day	2050	4.6	2.5	1.2
2 day	1800	9.1	6.0	7.6
3 day	1550	31.4	25.8	23.2
4 day	1900	36.0	35.7	40.9
5 day	2350	46.8	46.7	46.7

to hatch produced normal larvae, pupae, and adults. There was no observable difference in the gross morphology of these individuals when compared to those that were untreated.

The effects of ultrasonic vibrations on oxygen consumption are shown in Table 2. The rate of oxygen consumption was considerably lower in treated eggs than in the controls. Percentage values were calculated, and the treated 0, 1, 2, and 3 day eggs showed a reduction in oxygen consumption ranging from 12.9 to 28.5% with most values representing a reduction of 20% or more. Eggs treated on the last two days of embryonic development exhibited a reduction in oxygen consumption ranging from 8.4 to 22.6% with most values representing a reduction of less than 20%.

A statistical treatment of the values obtained for oxygen consumption in normal and treated eggs is given in Table 3. Significant decreases were observed in all instances when 0, 1, 2, and 3 day eggs were treated at power settings of 20 and 30 watts. At 10 watts the decrease was not significant. Treatment of 4 and 5 day eggs at 10 and 20 watts did not result in significant decreases, but at 30 watts there was a significant reduction in 5 day eggs.

Table 2. Comparison of oxygen consumption in untreated and ultrasonicated eggs of the mealworm, *T. molitor*, treated during embryonic development for 15 seconds with ultrasonic vibrations of 20 kilocycles per second at power settings of 10 watts, 20 watts, and 30 watts. The rate of oxygen consumption is expressed as microliters of oxygen/50 eggs/hour. Values are given with their standard errors.

	Microliters oxygen/50 eggs/hour			
Age of eggs	Untreated eggs	20 kc./sec. 15 sec., 10 watts	20 kc./sec. 15 sec., 20 watts	20 kc./sec. 15 sec., 30 watts
0 day	8.17 ± 0.55	6.82 ± 0.69	6.37 ± 0.43	5.98 ± 0.73
1 day	11.42 ± 1.05	9.77 ± 0.99	8.63 ± 0.85	8.77 ± 0.56
2 day	11.36 ± 0.87	8.85 ± 0.84	9.17 ± 0.57	8.12 ± 0.76
3 day	11.20 ± 0.74	9.76 ± 0.71	8.95 ± 0.44	8.77 ± 0.81
4 day	14.21 ± 1.39	12.46 ± 1.10	12.50 ± 1.25	11.39 ± 0.83
5 day	16.18 ± 1.11	14.38 ± 1.38	14.82 ± 1.29	12.53 ± 0.80

TABLE 3. Probable significance of differences obtained in the rates of oxygen consumption in untreated eggs of the mealworm, *T. molitor*, and eggs treated during embryonic development for 15 seconds with ultrasonic vibrations of 20 kc./sec. at power settings of 10, 20, and 30 watts.

Ages compared	Difference between means	Standard error of difference	P* value
0 day			
Untreated and treated at 10 watts	1.35	± 0.88	> 0.1
Untreated and treated at 20 watts	1.80	± 0.70	< 0.02
Untreated and treated at 30 watts	2.19	± 0.91	< 0.05
1 day			
Untreated and treated at 10 watts	1.65	± 1.44	> 0.2
Untreated and treated at 20 watts	2.79	± 1.35	0.05
Untreated and treated at 30 watts	2.65	± 1.19	< 0.05
2 day			
Untreated and treated at 10 watts	2.51	± 1.21	< 0.05
Untreated and treated at 20 watts	2.19	± 1.04	< 0.05
Untreated and treated at 30 watts	3.24	± 1.16	0.01
3 day			
Untreated and treated at 10 watts	1.44	± 1.03	> 0.1
Untreated and treated at 20 watts	2.25	± 0.86	< 0.02
Untreated and treated at 30 watts	2.43	± 1.10	< 0.05
4 day			
Untreated and treated at 10 watts	1.75	± 1.77	> 0.3
Untreated and treated at 20 watts	1.71	± 1.87	> 0.3
Untreated and treated at 30 watts	2.82	± 1.62	> 0.05
5 day			
Untreated and treated at 10 watts	1.80	± 1.77	> 0.3
Untreated and treated at 20 watts	1.36	± 1.70	> 0.4
Untreated and treated at 30 watts	3.65	± 1.37	< 0.02

* Probability values of 0.05 or less are considered statistically significant.

DISCUSSION

Embryonic development in the egg of *Tenebrio molitor* has been described by Ewest (1937) as consisting of blastoderm formation, stratification, separation of organ systems, and histological differentiation. The extreme sensitivity of 0 day eggs to ultrasound may be associated with the processes of cleavage and blastoderm formation occurring at this time. Since eggs were collected every 24 hours, those labelled 0 day may vary in age from just laid to 24 hours. During this period the observation of the following has been reported: maturation divisions and union of the male and female pronuclei; cleavage divisions and population of the egg by 512 nuclei; separation of primary and secondary "vitellophagen" or yolk liquifying cells; migration of nuclei towards the periphery of the egg and their entrance into the peripheral layer to form the blastoderm. This is in agreement with Counce and Selman (1955) who noted that treatment at any particular ultrasonic intensity for a given time produced maximum lethality when the eggs of *Drosophila melanogaster* were at the stage during which the nuclei migrate to the periphery to form the blastoderm. The continued sensitivity of 1, 2, and 3 day eggs to ultrasonic vibrations, although not as marked as that of 0 day eggs, may be associated with the formation and growth of the germ band and the separation of the organ systems taking place during this period. The greater resistance of the 4, and especially the 5 day eggs, to ultrasound may be associated with histological differentiation. During this time dorsal closure, pigmentation of eyes and mouth extremities, completion of the embryo, active movement and hatching occur. According to Fritz-Niggli and Böni (1950), it seems probable that early egg stages of an insect are more susceptible to ultrasonic vibrations than are later stages which are characterized by proliferations or cytological differentiation of tissues.

That resistance to ultrasound increases with age is supported by the data obtained both for the percentage of hatching and the rate of oxygen consumption for eggs treated on each of the days of embryonic development in the present work, as well as by reported results of other investigators. Fritz-Niggli and Böni (1950) found that in *D. melanogaster* resistance to ultrasonic intensities of 0.3 to 4.0 watts/cm^2 at the beginning of puparium formation increased nearly a thousandfold as compared with that of the egg when laid.

Increased resistance of the egg to ultrasound with age may also be associated with the structure of the egg membranes. Ewest (1937) observed that the egg of *T. molitor* is covered by an inner delicate vitelline membrane and an outer coarse chorion. These coverings are soft and sticky in the freshly laid egg but strengthen during the developmental period.

The reduction in the percentage of hatching from 85.1% in the normal egg of *T. molitor* to values ranging from 1.8% after ultrasonic treatment of 0 day eggs to 46.8% in treated 5 day eggs is much greater than that obtained by Quraishi, Osmani, and Ahmad (1963) when eggs of the mosquito, *Aedes aegypti*, were treated with vibrations of 500 kc./sec. for 30 seconds. They found a reduction from 62.5 to 55%. These same investigators found that when the eggs were treated for 25 seconds, the percentage of hatching was equivalent to the control; and after treatment for 15 and 20 seconds, a higher percentage resulted. A stimulation and acceleration of hatching was reported by Getsova, Lapinskaia, and Khenokh (1958) for eggs of the Shantung silkworm, *Antheraea pernyi*, treated for 1 to 30 minutes with waves of 125 kc./sec., and by Sautet, Levavasseur, and Vuillet (1947) for eggs of the mosquitoes, *Anopheles maculipennis*, *Culex pipiens*, and *Aedes mariae* treated for 30 seconds with vibrations of 960 kc./sec. These variations in the influence of ultrasound on the percentage of hatching may be explained by the observations of many investigators that the effects depend on the characteristic features of different species as well as on the intensity and duration of treatment.

The significant decrease in the rate of oxygen consumption observed in 0, 1, 2, and 3 day eggs of *T. molitor* after ultrasonic treatment may be compared with the results obtained by Kocian (1936), who found that exposure of 5 to 10 minutes in a high frequency electric field lowered the oxygen consumption in pupae of *T. molitor*. Kadoum, Ball, and Stetson (1967) found that the rate of oxygen consumption rose promptly when larvae of *T. molitor* were exposed to radiofrequency electric fields of 39,000 kc./sec.

The lower rate of oxygen consumption in eggs of *T. molitor* subjected to ultrasound suggests an altering of tissue metabolism and an adverse effect on the overall physiological state of the developing embryo. Enzyme disturbance may be responsible for the resulting metabolic changes. According to Él'piner (1964) and Él'piner, Faikin, and Basurmanova (1965) nonlethal doses of ultrasound may bring about the appearance of delicate, possibly reversible, biochemical and functional changes in the irradiated organisms. In these conditions not only are the processes of permeability and diffusion in the superficial layers of the cell modified, but also spatial relationships between the submicroscopic structures and between the macromolecular complexes incorporated in these structures are disturbed. These authors postulate that as a result of these disturbances, the spatial orientation of the cellular macromolecules is modified, and is accompanied by the "exposure" of new enzymic centers, functional groups of molecules, and specific receptors, situated mainly in the superficial layers of the cell.

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Host Acceptance of *Culex pipiens* L.[1] (Culicidae: Diptera)[2]

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Abstract: Pupae of *C. pipiens*, collected from a swamp, were separated into two groups. One group of adults engorged on a guinea pig, the other on a canary. Hosts remained with mosquitoes for 12 hour periods (overnight) for 30 consecutive days. Engorged females were counted daily and transferred to ovipositing containers. Results indicate that *C. pipiens* are highly ornithophilic, but will engorge on a mammal when the latter is the only host available. Furthermore, a peak feeding period is confirmed when the avian is the host.

INTRODUCTION

Mosquito host preference has been the subject of many investigations during the past two decades. Nevertheless, the importance of *C. pipiens* as a blood sucking insect is not clear. This is apparent in appraisals of its range of acceptable hosts which, when more precisely determined, might provide us with some information towards a solution of problems associated with the epidemiology of the St. Louis Encephalitis virus. Reeves and Hammon (1944) found that *C. pipiens*, from the Yakima Valley in Washington, were largely ornithophilic with infrequent mammal feedings. More recently Hayes (1961), Crans (1964,1968), Tempelis, *et al.*, (1967), and Means (1968) confirmed this while testing populations from Massachusetts, New Jersey, Delaware, Colorado and New York respectively. However, studies by Edman and Downe (1964), Ekis and Hagmann (1966), and Murphey, *et al.*, (1967) report substantial mammalian blood engorgement by some populations of *C. pipiens*.

MATERIALS AND METHODS

Pupae were collected from a polluted swamp at Oxford, New Jersey. All work was conducted in a laboratory at an average temperature of 79° F. and an average

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[1] Specimens were collected from a population identified as *C. p. pipiens* L. by R. A. Barr.

[2] Part of a thesis submitted for the degree of Master of Science of Rutgers University, New Brunswick, N.J. Paper of the Journal Series, Agricultural Experiment Station, New Brunswick, New Jersey.

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60% humidity. Room illumination was controlled by blacking out windows and using artificial light to provide a total photoperiod of 16 hrs. Variation in light intensity for simulated dawn and dusk followed the curves reported by Garay (1964).

Adult holding equipment consisted of a 1 ft. wooden cage covered on top with 16 × 16 mesh plastic screening; other sides were made of fiber board. Access to the cage interior was through an orthopedic stockinet sleeve. A 5% honey solution, in a 50 ml. flask containing three 6″ dental rolls, served as energy food. Adults accepted the solution when renewed every 2 or 3 days, before fermentation or molding occurred.

One thousand pupae were introduced into each of two cages and allowed 36 hrs. for emergence. The remaining pupae were counted and discarded. A guinea pig confined in a cylindrical plastic restrainer was introduced into one cage of newly emerged mosquitoes. A canary enveloped in a single layer of cheesecloth was placed in the second cage of newly emerged mosquitoes. Hosts remained in the cages for 12 hr. feeding periods (overnight) for 30 consecutive days. Each morning engorged females were counted and transferred into oviposition containers. Egg boats were studied to determine number and viability of eggs produced from the two sources of blood. Daily mortality records were kept to determine sex ratios and number of available females for blood engorgement. The experiment was replicated three times. The data were subjected to a factorial analysis of variance and 95% least significant intervals were constructed about selected means to confirm peak host-feeding periods.

RESULTS AND DISCUSSION

Results show 82% of the females engorged on the avian host, 44% engorged on the mammalian; the total number of available females were 1134 and 903 respectively. Investigations by Murphey, *et al.,* (1967) provided somewhat similar results. Their work reports 81% avian feeding and 30% mammalian feeding. These workers, however, utilized 8 species of birds and 7 of mammals while the present study employed only one species of each. The statistical analysis of results indicates that the *host* × *day* response was significant at the 1% level of probability. In other words, the feeding pattern on the bird was significantly different from that on the mammal. In addition, analysis of the least significant intervals at the 95% level of probability, confirmed peak feeding period when the avian serves as the host (Fig. 1). This peak seems to range from the 2nd to the 7th day, with most females feeding on day 4. With the mammalian host, mosquito engorgement fluctuates haphazardly throughout the duration of the experiment with no significant peak.

There are three possible reasons why a peak host-feeding period is lacking when *C. pipiens* are restricted to a mammalian host. Females may vary for the

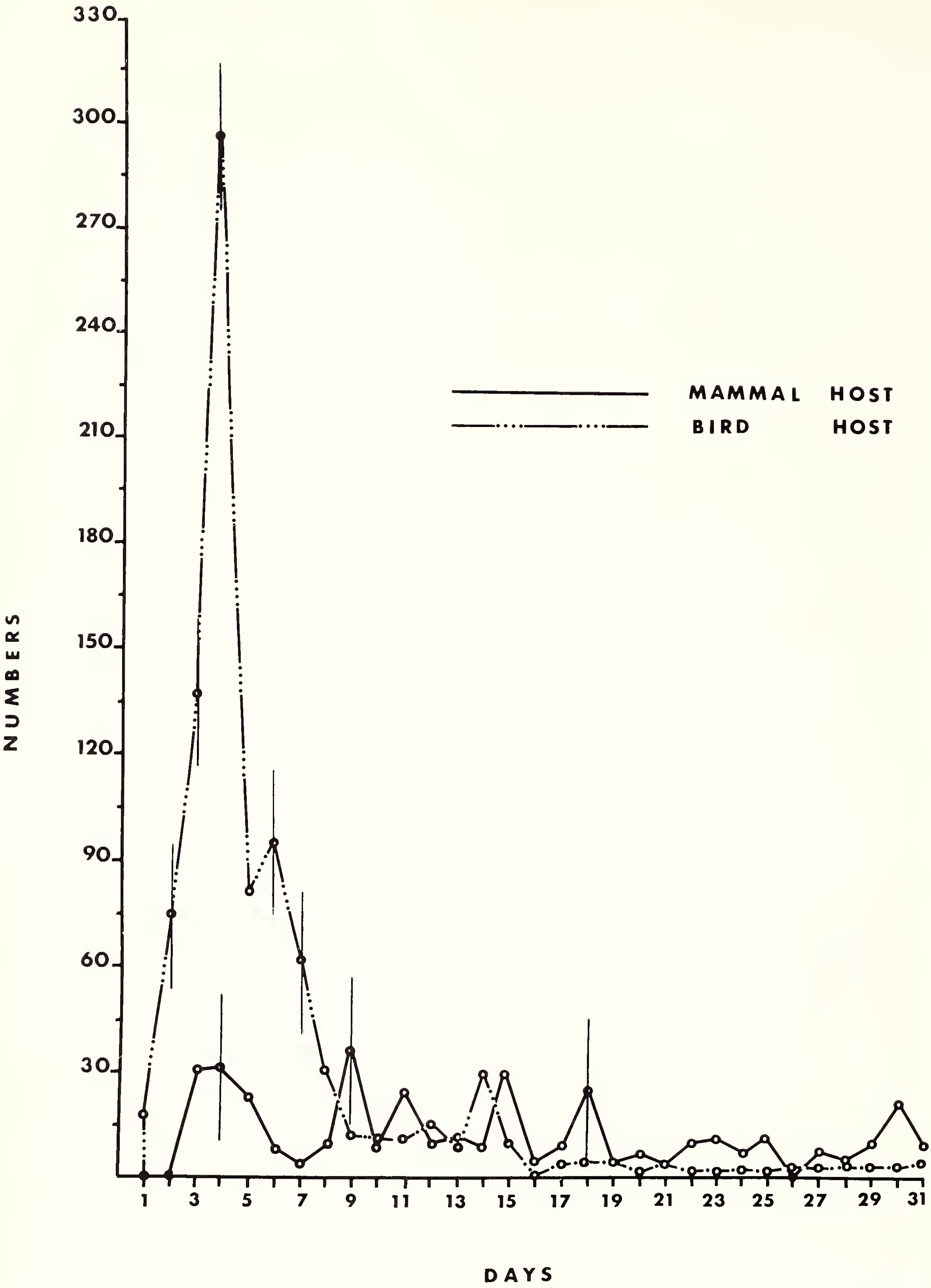

Fig. 1. Average number of engorged females when subjected to an avian or mammalian host. Means with corresponding vertical lines are not significantly different at the 5% level.

time when they become sufficiently "hungry" to engorge on a mammalian host; possibly a consequence of difference in larval nutrition. Such variation might produce the haphazard feeding pattern described above. Age may also play a substantial role in engorgement. Unable to feed on the preferred host, females may delay engorgement to a point where they either feed on whatever host is available, or reduce (or even forfeit) their reproductive potential.

In addition to host preference and age, host emanation differences may cause specific feeding responses of mosquitoes. The factors implicated in the location and recognition of the host by mosquitoes are heat, moisture, carbon dioxide, odor, and various visual criteria (Clements, 1963). There is some evidence that the first three are the principal host emanations that attract female mosquitoes to their hosts (Daykin, *et al.,* 1965). Since avians have a greater metabolic rate than mammals, it is reasonable to expect that emanations from the former should be proportionally greater than those obtained from the latter (Wallace, 1955; Romer, 1964). Proportionally more metabolic excretions and higher body temperature of the avian could explain, at least in part, the difference in the host acceptance of *C. pipiens.*

Hatchability data revealed no difference in the viability of eggs. Females that engorged on the bird, however, produced 50% more egg boats of 200 eggs. This difference could be attributed to a greater protein content within the nucleated red-blood cell of the avian host. Mattingly (1946), working with *C. fitigans,* found that this culicine also produces more eggs on an avian blood meal.

CONCLUSION

Culex pipiens are highly ornithophilic but will feed on a mammal when this is the only host available. When subjected to an avian host, females have a peak feeding period that ranges from the 2nd to the 7th day following emergence with the highest peak occurring on day 4. This was not true when the mammal served as the host. No difference in egg viability was observed in eggs produced from the two sources of blood, although females that engorged on the avian produced larger egg boats. It seems to me that these results warrant field investigations of *C. pipiens* populations from all pertinent habitats (e.g., engorged females from mammal burrows) with an overall objective of reexamining the possible role of *C. pipiens* as an omnivorous vector for transmission of St. Louis encephalitis and other arborvirus.

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Genetic Control of Melanism in *Panthea furcilla* (Packard) (Lepidoptera: Noctuidae)

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Abstract: The history of melanism in *Panthea furcilla,* and methods for rearing and mating this moth are presented. Based on rearing data of *P. furcilla* it is tentatively concluded that melanism in *P. furcilla* is controlled by a single, sex-linked, dominant gene.

The phenomenon of industrial melanism in the Lepidoptera has been noted and studied since the turn of the century. Briefly, the term industrial melanism refers to the spread of black or dark forms of normally light-colored, cryptic moths in areas subject to industrial pollution. Study of this process has taken place primarily in the British Isles (reviews in Kettlewell, 1961; Ford, 1964). Although this phenomenon is not rare in America, it has received little attention here. Owen (1961, 1962) and Sargent (1971) both make the point that further study of industrial melanism in America is needed.

One American moth which has been studied is *P. furcilla* (Packard) (Lepidoptera, Noctuidae). Klots (1964, 1966, 1968) has done some light trapping of wild adults and some rearing studies on this species and has devised a tentative scheme of inheritance of melanism in *P. furcilla.*

HISTORY

P. furcilla is, in the broad sense, a legitimate industrial melanic. The melanic form of *P. furcilla* (*atrescens,* McDunnough), first described from a specimen taken at Norway Bay, Quebec, Canada, on July 16, 1937 (McDunnough, 1942), makes up substantial portions of at least two populations in New England (Klots, 1964, 1966, 1968b; Sargent, personal communication).

BACKGROUND OF THE PRESENT STUDY

P. furcilla is an excellent subject for rearing studies on melanism for several reasons. First, the melanic and typical forms of *P. furcilla* are distinct (see plate 1). The life history of *P. furcilla* also makes it a good organism for research of this type. The caterpillar feeds primarily on white pine, *Pinus strobus* (L.),

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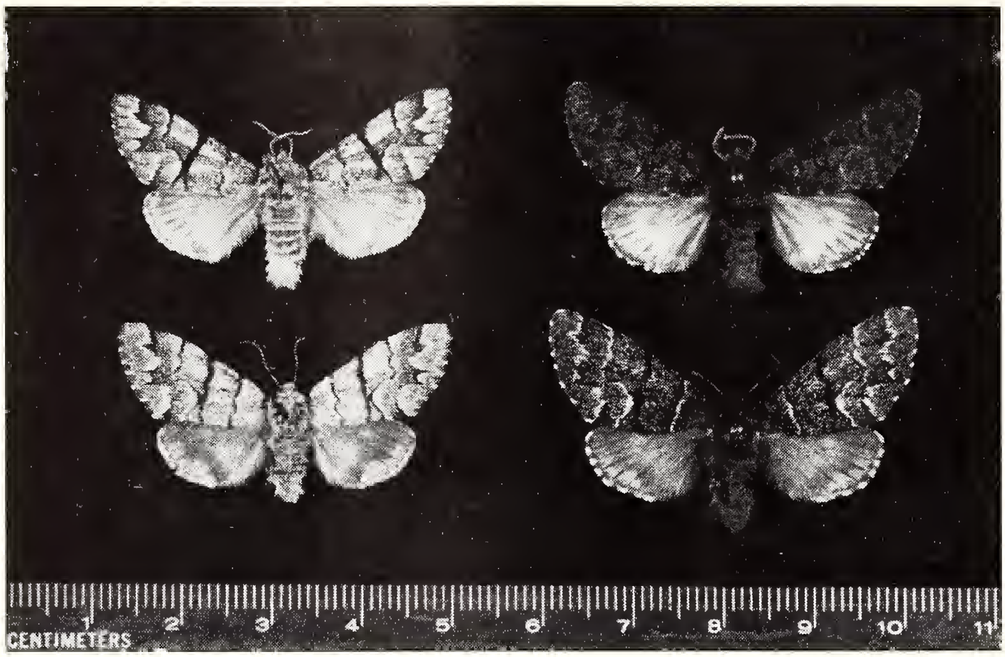

Plate 1. Panthea furcilla Typicals (L.) Melanics (R.) Males (Top) Females (Bottom)

a feeding habit that insures a food supply of year around availability. This is important, since caterpillars of *P. furcilla* that are kept at high temperature and on a long photoperiod, show no diapause. The species is, in this area, bivoltine, so wild adults are available twice each summer, in June, and in August. Also, *P. furcilla* is common in the Amherst area so breeding stock is easily obtained.

All wild-caught moths used in this experiment were collected at lights, in Leverett, Massachusetts. The white pine used in this study was also from Leverett. Leverett is located about 25 air miles north of Springfield, 75 air miles west of Boston and 66 air miles east of Albany, New York. The area apparently receives little air-borne pollution. Lichens are common on trees and rocks, and the environment shows no visible darkening by soot or other air pollution fallout. The population of *P. furcilla* in Leverett is, however, approximately 50% melanic (Sargent, personal communication).

Rearings in this study were conducted on branches of white pine contained in water-filled gallon milk jugs. These were placed in screen cylinders 36″ high by 22″ in diameter, with a screen lid. A 1″ thick layer of pine needles was put in the bottom of the cage as a place for the caterpillars to pupate. Rearing conditions of 85–95% relative humidity, 70–75°F, and a photoperiod of 16 hours light/8 hours dark gave best results. Under these conditions survival was almost 50% from eggs to adult in the case of rearing I-M.

In the case of laboratory matings the system which met with the most success was as follows:

Late in the afternoon a recently emerged male and female were placed in a mating cage consisting of a screen cylinder 18″ high and 9″ in diameter, with sheets of cardboard for top and bottom. A small branch of white pine was also put in the cage. This arrangement was then left alone for 72 hours. At the end of this period male, female, and eggs, if any, were removed. Approximately 60% fertile matings resulted.

RESULTS OF REARINGS

Group I-M was reared from 184 eggs obtained from a wild caught melanic female. The results were as follows:

Typical male (T♂), 0; Typical female (T♀),45; Melanic male (M♂), 39; Melanic female (M♀), 0; Total, 84.

Group I-N was reared from 200 eggs from the mating of a typical female and a typical male. The results were as follows: T♂, 45; T♀, 48; M♂, 0; M♀, 0; Total, 93.

Group II-3 was reared from 126 eggs from a mating of a melanic male and typical female, both from group I-M. The results were as follows: T♂, 14; T♀, 11; M♂, 9; M♀, 14; Total, 48.

Group II-5 was reared from 93 eggs resulting from a mating of a typical female from group I-M and a typical male from group I-N. The results were as follows: T♂, 13; T♀, 13; M♂, 0; M♀, 0; Total 26.

DISCUSSION

The results of rearing I-M and II-3 make a strong case for the control of melanism in *P. furcilla* by a single, sex-linked, dominant gene. Group I-M yielded all typical females and melanic males. Two hypotheses may explain the results of rearing I-M, that of melanism being controlled by a sex-linked dominant and that of melanism being sex-limited. The eggs in rearing I-M were obtained from a melanic female so the second hypothesis must be rejected, leaving sex-linked dominance as the only possibility. In moths, females are XY and males XX, therefore the female in question must have mated with a typical male. The males in group I-M must have been heterozygous with respect to melanism. If one then crossed a melanic male from group I-M with a typical female one would expect a 1:1:1:1 ratio, typical males to typical females to melanic males to melanic females. Rearing II-3 represents such a cross, and the results do not differ significantly from those expected. ($\chi^2 = 1.78$, $P > .50$.) Table 1, which compares the results of rearing I-M with expected ratios assuming different types of inheritance, shows that sex-linked dominance is the only explanation to which the observed results conform.

Table 2 contains the results of my experimental rearings, all of Klots' rearings in which phenotype and sex of individuals were given (and which gave somewhat odd results) and one rearing by Sargent. These results are also compared with the results expected assuming melanism to be a sex-linked dominant and chi-square values based on this comparison are given. Rearing I-S (Sargent, unpublished)

TABLE 1. A comparison of the results of rearing I-M with expected results assuming different types of inheritance.

Observed results of rearing I-M

T♂	T♀	M♂	M♀
0	45	39	0

Expected results assuming different types of inheritance

Types of Inheritance	Mating*	Numbers of Moths T♂	T♀	M♂	M♀
Sex-linked dominant	M♀ × T♂	0	42	42	0
Sex-linked recessive	M♀ × T♂ ht	21	21	21	21
Sex-linked recessive	M♀ × M♂	0	0	42	42
Autosomal dominant	M♀ ht × M♂ ht	10.5	10.5	10.5	10.5
Autosomal recessive	M♀ × T♂ ht	21	21	21	21

*—Genotypes of all males assumed
ht—heterozygous

and rearings K-Pf M-1 and K-Pf Ms-2 (Klots 1968) all were from eggs obtained from wild caught melanic females. If one assumes that these females had mated with heterozygous melanic males, and that melanism is controlled by a sex-linked dominant gene, the cross can then be expressed, calling melanic M and typical m, MY × Mm. This cross is diagrammed as follows:

	M	m
M	MM	Mm
Y	MY	mY

Thus a ratio of 1:2:1, melanic females to melanic males to typical females, would be expected. None of the results obtained differ significantly from this, (see Table 2). Only one rearing cited, K-Pf 7 (Klots, 1968), a mating of a typi-

TABLE 2. Results of various rearings compared with results expected, assuming sex-linked dominance.

Rearing	Observed T♂	T♀	M♂	M♀	Expected T♂	T♀	M♂	M♀	χ^2	P
I-M	—	45	39	—	—	42	42	—	.43	>.50
II-3	14	10	9	14	11.75	11.75	11.75	11.75	1.77	>.50
K-Pf M-1[1]	—	11	5	—	—	8	8	—	2.24	>.10
K-Pf M-1[2]	—	15	27	16	—	14.5	29	14.5	.32	>.80
K-Pf Ms-2[2]	—	4	6	7	—	4.25	8.5	4.25	2.25	>.20
K-Pf (7)[2]	—	3	4	1	2	2	2	2	*	*
I-S[3]	—	3	8	3	—	3.5	7	3.5	*	*

* Sample size too small to apply chi-square

cal female and a melanic male, gives results different from those expected. But the sample size was not large enough to make this difference significant. The conclusion that melanism in *P. furcilla* is primarily controlled by a sex-linked dominant does not agree wholly with Klots' (1968) hypothesis on the nature of inheritance of melanism in *P. furcilla*. Klots says that melanism is dominant, but not completely so. He also says that melanism in *P. furcilla* is probably controlled by two genes, one which produces the phenotype "wholly melanic" and another which produces the phenotype "very strongly melanistic." He further states that these two phenotypes show no inter-gradation. Klots (1968) also reports, in his wild caught samples, a class, comprising some 18% of the population, which is "slightly to strongly melanistic." In looking at Klots' data one notices that this category is absent from all rearings, with the exception of some slightly melanistic individuals reported in the 1966 paper. In this report Klots makes repeated reference to pupal mortality during "hibernation." From this reference one might surmise that the pupae were kept in a cold place. It has been noted that low temperatures administered to moth pupae can cause darkening in the adult (Merrifield, 1890, 1891; Kettlewell, 1943). This then may be the origin of Klots' slightly melanistic individuals. Since I have not seen Klots' wild-caught series, I cannot comment further on this.

The other problem which Klots' data present is the mutually exclusive wholly melanic and very strongly melanistic categories. The melanic *P. furcilla* I have seen are not easily assigned to exclusive categories. Some are a bit darker than others, especially in the males. This would seem to suggest a possibility of some degree of incomplete dominance. Two of Klots' rearings, K-Pf M-1 (1966) and K-Pf M-1 (1968), involve "wholly melanic" females, but K-Pf Ms-2 is from a "very strongly melanistic" female, and while this last sample is a bit small, they all fit the hypothesis of melanism being a sex-linked dominant. While there may be modifiers or environmental factors at work which make melanics lighter or darker, it must be said that on the basis of present data that melanism in *P. furcilla* seems predominantly under the control of a single sex-linked dominant gene.

Certainly the genetics of melanism in many species, including *P. furcilla*, deserves further study, as does the phenomenon of industrial melanism itself.

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Melanism, Ring-segments, and Associated Abnormalities in Female Hover Flies (Diptera: Syrphidae)

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Abstract: Various combinations of morphological abnormalities have been found in females of 23 species of *Megasyrphus, Melangyna, Melanostoma, Metasyrphus, Platycheirus, Pyrophaena, Scaeva,* and *Sphaerophoria* (Syrphidae:Syrphinae). Cases of melanism in females associated with ring-like terminal abdominal segments, absence of ovaries, absence or reduction of spermathecae, irregularly arranged abdominal surface hairs, development of male secondary sexual characters, and reduced size are reviewed. The usefulness of these characters as objective means of recognizing invalid species based on aberrant specimens is discussed. *Sphaerophoria cleoae* Metcalf, described from abnormal females, is placed as a *nomen dubium.*

While preparing a taxonomic revision of the New World species of *Sphaerophoria* Lepeletier and Serville, I found that *S. cleoae* Metcalf (1917) was based on abnormal females that are melanoid, have ring-like terminal abdominal segments (Fig. 2, 4, 5, 9) and lack spermathecae. A survey of the literature on morphological abnormalities of Syrphidae indicated that ring-like segments and certain other abnormalities routinely occur together in some combination and only in melanoid females. This phenomenon appears to be of widespread occurrence in the subfamily Syrphinae. Its recognition should be useful as a more objective means of determining whether or not certain "species" are in fact true species or simply aberrant forms of other species. Thus, species whose holotypes are abnormal females of this kind must be considered "unrecognized species" if they cannot be identified on other, normal features. Because much of the species classification of the Syrphidae has been based on color characters, it is likely that recognition of the "melanoid syndrome" of abnormal features may be especially useful in this family. Correlated morphological abnormalities in one sex only may well occur in other groups of Diptera and may have similar practical application in the taxonomy of these groups.

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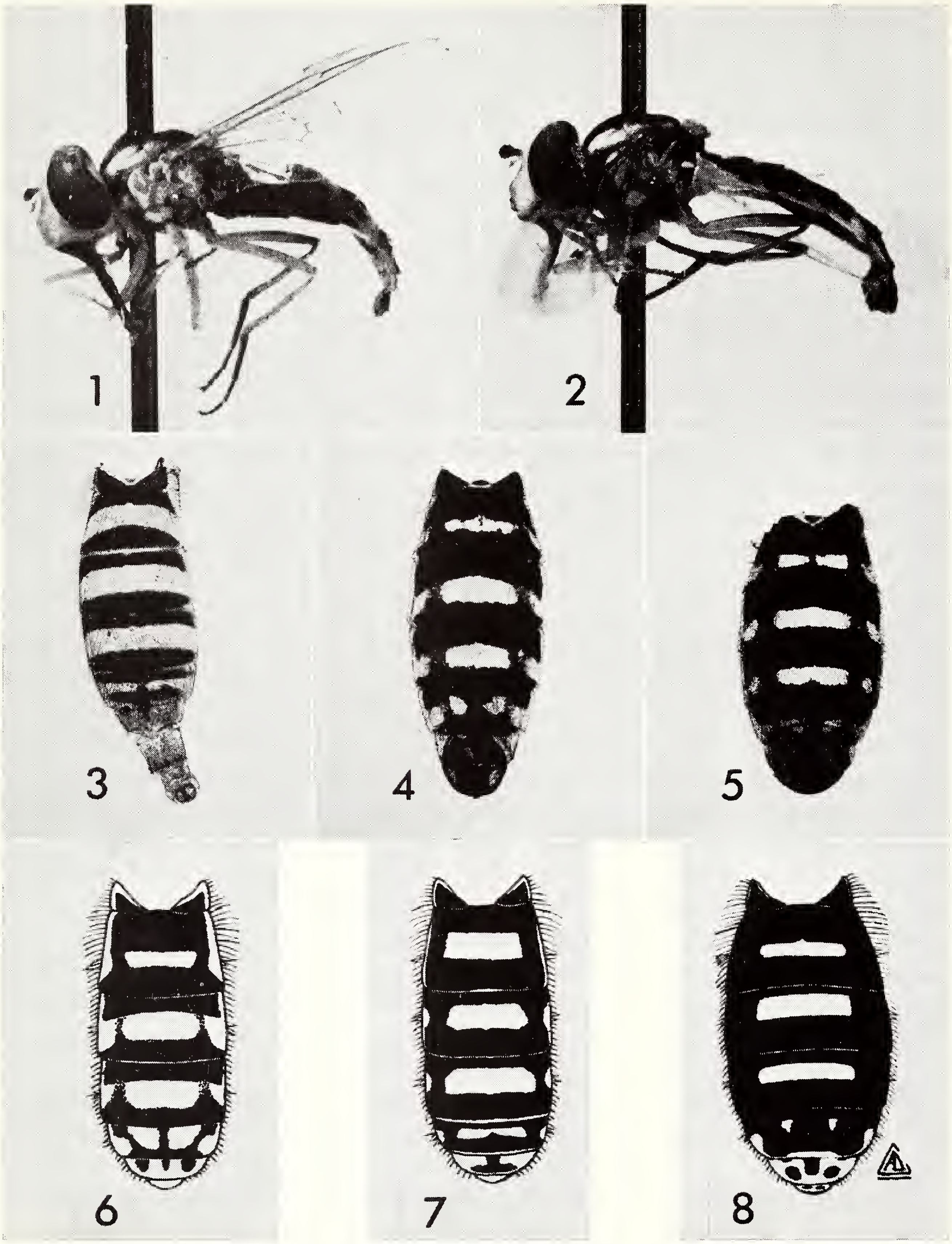

Figs. 1–8, *Sphaerophoria* spp., females. Figs. 1, 2, *S.* sp. Scripta Group, Abbreviata Section; habitus, lateral view. 1. specimen with normal abdominal segments, Ithaca, New York. 2. specimen with ring-like terminal abdominal segments, Orono, Maine. Figs. 3–8, abdomen, dorsal view. 3. *S. contigua* Macquart, Eagles Nest, Minnesota. 4. *S.* sp. Scripta Group, Abbreviata Section, paratype of *S. cleoae* Metcalf, Orono, Maine. 5. *S. sulphuripes* (Thomson), Amador Co., California. 6. *S.* sp. Scripta Group, Abbreviata Section, paratype of *S. cleoae,* Orono, Maine. 7. *S. contigua* Macquart, Waskada, Manitoba. 8. *S. sulphuripes* (Thomson), San Diego Co., California.

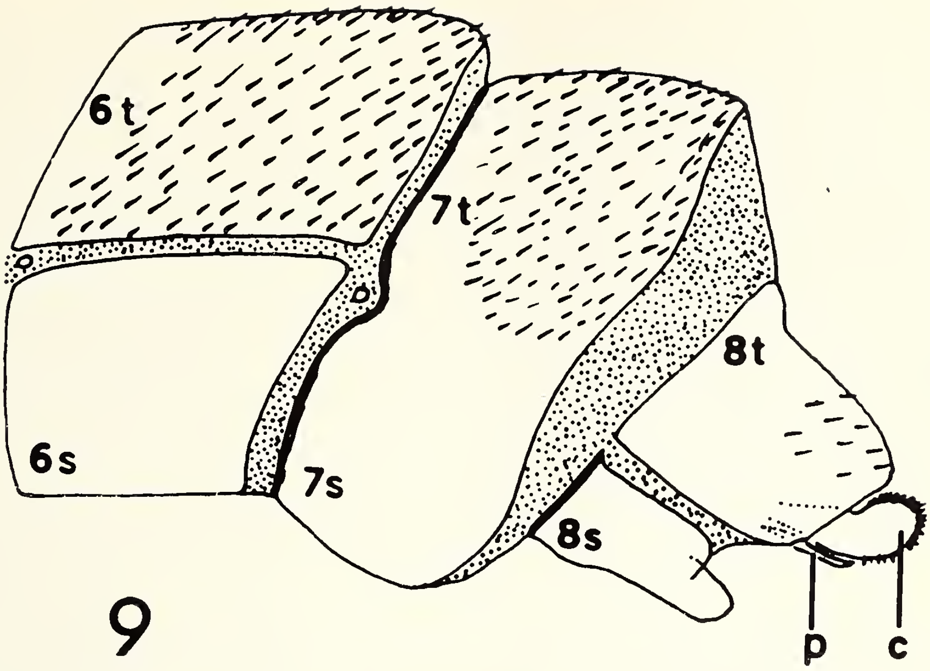

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Fig. 9. *S.* sp. Scripta Group, Abbreviata Section, female paratype of *S. cleoae* Metcalf, terminal segments of abdomen, lateral. c, cercus; p, proctiger; s, sternum; t, tergum.

REVIEW OF LITERATURE

A greater or less development of black pigment is a common phenomenon in male as well as female Syrphidae. Such variation is often treated in taxonomic papers, but usually without reference to associated morphological abnormalities. Several specific names have been proposed by earlier taxonomists for atypically dark specimens (males as well as females), and many of these have been subsequently placed in synonymy. A few workers in the Syrphinae have paid particular attention to melanism in females and occasionally to some of the following structural abnormalities associated with it:

1. development of male features in secondary sexual characters
2. ring-like terminal abdominal segments
3. pronounced sclerotization of abdominal segments
4. absence of ovaries
5. absence or reduction of spermathecae
6. reduction in body size

A form of the common *Scaeva pyrastri* (L.) with a completely black abdomen was described as a separate species (*Scaeva unicolor*) by Curtis (1834) and has been treated as a variety by most subsequent authors. Only females of the melanoid form are known. Kessel (1926) referred to this variety as a case of sex-limited polychromatism. In a random collection of 277 specimens made during

June at Davis, California, he found that 98 females and 137 males were normally-colored, but 42 females were completely melanoid. He also mentioned 6 intermediately-colored females collected at various localities. Of 392 North American specimens of *S. pyrastri* in the USNM, 25 are melanoid, and all of these are females. Abdominal terga and sterna 6, 7, and 8 of melanoid specimens are shorter, broader, and more heavily sclerotized than those of normal specimens. The terga and sterna of segments 7 and 8 of melanoid specimens are connected by strong lateral sclerotization to form a complete ring. Some melanoid specimens are small, but others are of normal size. The frons is not abnormally narrowed (a male secondary sexual character), and the hairs on the abdominal terga are not disarranged. Three well developed spermathecae are present.

Štys (1961) summarized reports of melanoid females with incompletely developed male characters, i.e., holoptic head and broadened tibiae and tarsi, in *Melanostoma mellinum* (L.), *M. scalare* Fabricius, *Platycherius albimanus* (Fabricius), *P. peltatus* (Meigen), *P. scutatus* (Meigen), and *Pyrophaena granditarsa* (Forster) (all Melanostomini).

Van Doesburg (1964, 1970) described several melanoid females without ovaries (*Scaeva pyrastri,* 2 specimens; *Megasyrphus annulipes* (Zetterstedt), 25; *Metasyrphus lapponicus* (Zetterstedt), 2; and *Melangyna umbellatarum* (Fabricius), 2). He noted that these females were smaller than normally colored specimens. He surmised that the cause of the melanism and absence of ovaries was, "... a non-fatal parasitic attack during an earlier stage of the life of the flies."

Syrphus brevicinctus Kanervo, described from 1 female from Siberia, was synonymized under *S. ribesii* L. by Hippa (1968). The holotype of *S. brevicinctus* and 5 additional specimens from Finland and USSR, all females, are indistinguishable from *S. ribesii* except in characters of the abdomen. There is some variation in the extent of development of the black pigmentation of the abdomen, but all specimens of "*S. brevicinctus*" figured by Hippa are darker than *S. ribesii.* Hippa did not characterize any of the abdominal segments of *S. brevicinctus* as "ring-like" but he did state that, "In the ovipositor of *S. brevicinctus* the segments are very broad and developed more like the normal segments when compared with *S. ribesii.* . . . The ovipositor and the whole abdomen are extremely strongly chitinized as compared with those of *S. ribesii.*" Hippa surmised that the aberrant structures, ". . . are probably caused by some kind of metabolic disturbance . . ." He also mentioned a melanoid female of *Syrphus tricinctus* Fallén, ". . . in which the abdomen is of very similar aberrant form."

Andersson (1970a) first described ring-like segments in melanoid females. Thirteen specimens with ring-like abdominal segments 7 and 8 or segment 7 and with reduced spermathecae were described in detail for *Melanostoma mellinum*, *Platycheirus albimanus*, *P.* sp. (*?immarginatus* Zetterstedt), *Sphaerophoria rueppelli* Wiedemann, *S. scripta* L., and *S.* sp. (*menthastri* L. *s. lat.*).

The terga and sterna of abdominal segments 5 and 6 of the *Platycheirus* and *Melanostoma* specimens are not fused to form rings but they are shorter and broader than normal. The *Platycheirus albimanus* and 3 of the 4 *Melanostoma mellinum* specimens have secondary sexual characters developed somewhat as in the males. Two specimens of *Sphaerophoria scripta* (L.) each have the tergum and sternum of segment 7 fused to form a large, cup-shaped ring. The holotype of *Sphaerophoria flavicauda* Zetterstedt (= *S. rueppelli* Wiedemann) has a ring-like segment 7. In the holotypes of *S. insignita* Zetterstedt and *S. multipunctata* Zetterstedt (=*S. menthastri* L. *s. lat.*), ". . . abdominal segment 7 forms a large cup-shaped ring enclosing the cone-shaped abdominal tip." In a study of the type material of Zetterstedt's species of *Sphaerophoria,* Andersson (1970b) referred to the 3 above-mentioned holotypes of *Sphaerophoria* as "melanoid females."

An unusual species of *Sphaerophoria* from the Azore Islands, in which both males and females are entirely black except for a yellowish scutellum and partly yellowish legs, was described by Frey (1945). I have examined a female and a male paratype of this species (*S. nigra*), kindly sent to me by Dr. W. Hackman. Except for the extensive black coloration, both sexes of *S. nigra* are typical *Sphaerophoria.* The female has an exceptionally large seventh segment in which the lightly sclerotized tergum and sternum are fused, but it does not have any of the other unusual features associated with abnormal, "melanoid females." The male genitalia have the same general structure as members of the Scripta Group. Frey (1945) proposed a new subgenus for *S. nigra,* and placed all other species of the genus in the subgenus *Sphaerophoria.* I have elsewhere (Knutson, in prep.) proposed a different subgeneric classification, based mainly on characters of the male genitalia, in which *S. nigra* is placed in the typical subgenus and a new subgenus is proposed for *S. novaeangliae* Johnson (North America) and *S. viridaenea* Brunetti and *S. assamensis* Joseph (India).

NEW CASES OF MELANOID FEMALES IN *Sphaerophoria*

Sphaerophoria cleoae was described from 15 females collected at Orono, Maine, during 1915 and 1916 (Metcalf, 1917). Metcalf indicated that these specimens were specifically distinct because of the unusual, doubly interrupted yellow bars on the abdominal terga (Fig. 4, 6). While revising the New World *Sphaerophoria,* I examined about 13,000 specimens. Of these, 97 have an abdominal color pattern more or less as described for *S. cleoae.* All 97 specimens are females; abdominal segment 7 or segments 6 and 7 are large, ring-like, and unusually well-sclerotized; spermathecae appear to be absent; and the hairs on the dark bars connecting the dark anterior and posterior margins are elongate, erect, and irregularly arranged. These last 3 features were not mentioned by Metcalf. I have seen only 1 specimen of *Sphaerophoria,* an example of *S. con-*

tigua Macquart, with a ring-like seventh abdominal segment and a normally colored abdomen. There is no indication that *Sphaerophoria* with the *"cleoae"* color pattern are intersexes; the eyes of these specimens are separated as in normal females. Many, but not all, of the abnormal specimens are smaller than normal specimens of the respective species.

Surprisingly, females of at least 3 North American, 1 European, and 1 Japanese species of *Sphaerophoria* having the *"cleoae"* abdominal color pattern are represented among the 97 specimens that I have studied. One species among these 97 specimens, *S. sulphuripes* (Thomson), is recognized by the broad face, Y-shaped frontal stripe, anteroventrally darkened pteropleuron, and somewhat broadened abdomen. In that species, segment 7 is ring-like and sternum 6 is enlarged but separated from tergum 6 by membrane. Some specimens with the *"cleoae"* pattern are *S. contigua,* which is easily recognized by the normal face, wrinkled and apically narrowed midfrontal stripe, yellow anteroventral portion of the pteropleuron, and normal abdomen. Both segments 6 and 7 are ring-like in these specimens. A third group of specimens are either *S. philanthus* (Meigen), *S. abbreviata* Zetterstedt, or a new species of *Sphaerophoria* that I am describing elsewhere (Knutson, in prep.). I am not able to distinguish females of these 3 species. Usually only segment 7 is enlarged and ring-like in these specimens. Furthermore, the *"cleoae"* pattern and ring-like seventh segment have been seen in 1 female from Japan that appears to be *S. nigritarsi* Brunetti, and in 1 female of the Scripta Group from Spain.

Because the holotype and paratypes of *S. cleoae* are undeterminable females of either *S. philanthus, S. abbreviata,* or *S.* n. sp., the name *Sphaerophoria cleoae* Metcalf should be retained in the literature as a *nomen dubium* in case it eventually becomes possible to distinguish females of these species.

Metcalf (1917) did not mention variation of the abdominal color pattern of "*S. cleoae.*" It does vary as shown in Figs. 6–8. A paratype (*S. abbreviata, S. philanthus,* or *S.* n. sp.) is shown in Fig. 6; a somewhat darker specimen of *S. contigua* from Waskada, Manitoba, is shown in Fig. 7; and a dark specimen of *S. sulphuripes* from San Diego Co., California, is shown in Fig. 8. A few specimens of *S. sulphuripes* from southern California are even darker than that shown in Fig. 8, and 2 from Berkeley and Mix Canyon, California, are almost entirely black. Other specimens of *S. sulphuripes* are more lightly pigmented, as Fig. 7.

Type Specimens of *S. cleoae* Metcalf.—Holotype, female, labeled, "Me. Agr. Exp. Sta., Orono, Me., 16 Aug. 15; Mrs. Cleo F. Metcalf Collector; Type; *Sphaerophoria cleoae* Mtclf, C. L. Metcalf det." In the Florida State Collection of Arthopods. Paratypes: Maine, Orono, Agr. Exp. Sta., 2.VI.17, 1 female; 11.VIII.15, 2 females; 24.VIII.15, 1 female; Metcalf (MCZ); 12.VII.16, 1 female; 11, 19, 24.VIII.15, 6 females, Metcalf (INHS); 11.VIII.15, 2 females, Metcalf (FSCA).

Specimens with the *"cleoae"* color pattern occur at widely separated localities throughout much of the range of the following North American species. *S. contigua* (10 specimens). CANADA. MANITOBA. Waskada, 3.VIII.22, Criddle (CNC). Waskada (FMH). U.S.A. ILLINOIS. Winnebago Co., 11 mi. E. Rock Grove, 16.VII.69, Marlin, (INHS). Urbana, 27.IV.52, Smith (CNC); 24.VI.60, Waldbauer, (GPW). IOWA. Ankeny, 22.VII.62, Rotary Trap (ISU). KANSAS. Crawford Co., 993 ft., 1915, Beamer (AMNH). Douglas Co., 900 ft., Beamer (INHS). KENTUCKY. 25 mi. S. of Louisville, 18.V.1948, Roback (INHS).

S. sulphuripes (22 specimens). U.S.A. CALIFORNIA. Sacramento, 11.III.35, Keifer (CDA). 1 mi. SE. of Inverness, Marin Co., 24.VII.56, Ashlock (FSCA). Samuel Spring, Napa Co., 20.V.55, Browning (UCD). Woodland, 30.VIII.43, McClay (UCD). Gates Canyon, Solano Co., 9.V.56, Schlinger (UCD). 6 mi. W. Tragedy Spring, Amador Co., 16.VII.60, Moore (UCD). Milton, Calaveras Co., 21.X.17, Bradley (FMH). S. L. Obispo, 24.IV.19, Van Duzee (CAS). Berkley, 30.V.33, Bohart (CAS). San Diego Co., 25.VI.13, Van Duzee (CAS). Gazelle, Siskiyou Co., 11.IX.50, McClay (UCD). Mix Canyon, Solano Co., 14.IV.55, Jessen (UCD). IDAHO. Buhl, 3500 ft., 16.VIII.45, Shull (UIM). Hot Spring, Owyhee Co., 28.VI.53, Barr (UIM). Aberdeen, Bingham Co., 6.VIII.53, Gittins (UIM). OREGON. Hood River, Childs (UW). Salem, 21.VI.39, Knowlton (USU). Portland, 9.VII.39, Brookman (FSCA). Elgin, 23.VII.47, Cook and Wallace (UIM). Medford, Jackson Co., 24.IX.56, 9.IX.53, McClay (UCD). WASHINGTON. Pullman, Malaise Trap, 13.V.65, Akre (WSU).

S. abbreviata, S. philanthus, or *S.* n. sp. (49 specimens). CANADA. BRITISH COLUMBIA. Mission City, 28.VII.53, Mason (CNC). NORTHWEST TERRITORIES. Reindeer Depot, Mackenzie Delta, 2.VIII.48, Brown (CNC). U.S.A. ALASKA. Matanuska, VI.44, Chamberlin (USNM). Skagway, 22.V.23, Kusche (CAS). COLORADO. Estes Park, VIII.1892, Snow (UK). IDAHO. Franklin, Franklin Co., 25.VII.64, Knowlton (UK). R'dale, 15.IV.34, Smith (USU). Moscow Mt., 7.V.66, Dawson (WSU). Arena Valley, Canyon Co., 24.VII.58, Waters (UIP). 10 mi. E. Malad, Oneida Co., 6.VII.65, Gittins (UIM). Caldwell, 2375 ft., 23.VIII.64, Reyes (UIM). Parma, Canyon Co., 23.VIII.65, Reyes (UIM). 5 mi. SE. Nampa, Canyon Co., 18, 23.VII.63, Markin, (UIM). 4½ mi. SE. Nampa, Canyon Co., 18.VII.63, Markin (UIM). KANSAS. Baldwin, 7.V.52, La Berge (UK). MAINE. Easton, 18.VI.44, Bean (AMNH). Orono, 5.V.57 (USNM); 10.VIII.15, (INHS). Me. Agr. Exp. Sta., 11.VIII.15, (INHS). Orono, Agr. Exp. Sta., 13.VI.17, Metcalf, (INHS); 15.VI.17, Metcalf (UW). MASSACHUSETTS. Weston, 21.VII.63, Thompson (FCT). Wellesley, 9.V.63 (FCT). MICHIGAN. Crooked Lake nr. Lake Station, Clare Co., 13.VII.35, Olson and Gloyd (UMich). Gull Lake Biol. Sta., Kalamazoo Co., 1.V.64, Matthews (MSU). MONTANA. Bozeman, 4400 ft., 13.VI.03 (INHS). NEW YORK. Danby, 23.VII.32 (CU). NORTH CAROLINA. Valley of Black Mts., 11.IX.06, Beutenmiller (AMNH). OHIO. Columbus, 2.VII.30, Smith (FSCA). OREGON. Joseph, 24.VII.47, Cook and Wallace (UIM). SOUTH DAKOTA. Roubaix Camp, Black Hills Nat. For., 15.VII.57, Dietrich (CU). UTAH. Morgan, 24.VIII.62, Knowlton (UMinn). Soldier's Summit, 13.VII.54, Knowlton (UK). Farmington, 9.VII.51, Knowlton and Tibbetts (USU). Logan, 21.VIII.47, Popov (USU). WASHINGTON. Yakima Co., Bethel Ridge, 2.VIII.56, Lanchester (USNM).

S. nigritarsis Brunetti. JAPAN. L. Kawaguchi, Vamanashi 4.IV.31, Gressitt (CAS).

S. sp. Scripta Group. SPAIN. Montseny, VII.60, Krauss (USNM).

The abbreviations given in parentheses above indicate collections from which specimens were borrowed. These are: AMNH, American Museum of Natural History; CAS, California Academy of Sciences; CDA, California Department of Agriculture; CNC, Canadian National Collection; CU, Cornell University; FCT, F. Christian Thompson; FMH, F. M. Hull; FSCA, Florida State Collection of Arthropods; GPW, G. P. Waldbauer; INHS, Illinois Natural History Survey; ISU, Iowa State University; MCZ, Museum of Comparative Zoology, Harvard University; MSU, Michigan State University; UCD, University of California, Davis; UIM, University of Idaho, Moscow; UIP, University of Idaho, Parma; UK, University of Kansas; U Mich, University of Michigan; U Minn, University of Minnesota; USNM, United States National Museum; USU, Utah State University; UW, University of Wisconsin; WSU, Washington State University, Pullman.

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Mimetic Associations in Natural Populations of Tropical Papilionid Butterflies. (Lepidoptera: Papilionidae)

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Abstract: A long-term capture-mark-recapture program was conducted on *Parides* (Papilioninae) butterflies (*Parides arcas mycale*, *Parides arcas mylotes*, *Parides childrenae childrenae*, and *Parides erithalion sadyattes*) visiting the flowers of two widely-separated *Hamelia patens* (Rubiaceae) trees in Costa Rican lowland tropical rain forest. Adult populations, composed predominantly of males, were present at these two feeding sites for more than 12 successive months. These small populations were characterized by long-lived males not subject to heavy predation, and "residential" in terms of their local movements in the jungle. Such low-turnover populations persisted at feeding sites over long periods. This persistence, in addition to similar diurnal activity periods among species accounted for an effective Müllerian mimetic association. Females were highly vagile, presumably due to searching behavior for oviposition sites, and thus irregularly appeared at low frequency at the regular feeding sites of males. The localized distributions of males at their feeding sites could function primarily for initiation of courtship behavior in the jungle, favoring effective female dispersal after successful mating. Females may act as models in mimetic associations with other species (*Papilio anchisiades ideaus*, *Papilio* sp., and *Heliconius doris*) seen in the jungle, but like females of *Parides*, adults of these species were also irregular, infrequent visitors at these feeding sites and exhibited high vagility.

INTRODUCTION

This paper discusses a 14 month study on the size and structure of adult populations for tropical papilionid butterflies belonging to the genus *Parides* that comprise Müllerian mimicry complexes in a Costa Rican lowland tropical rain forest. Interest centers upon temporal trends in population size for each species in two mimicry complexes, changes in age-structure in populations of each species, relative survivorship of adults of each species from predation by birds, and upon diurnal patterns of activity for the different species. The species studied are:

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Parides arcas mylotes Bates (hereafter referred to as *Parides mylotes* to avoid confusion with the following subspecies), *Parides arcas mycale* Goodwin & Salvin (hereafter referred to as *Parides mycale* to avoid confusion with *Parides mylotes*), *Parides childrenae childrenae* Gray, and *Parides erithalion sadyattes* Druce. Based on geographical information given in Seitz (1924), it is held that the subspecies *mycale* of *Parides arcas,* known especially from Panama, represents a transitional form between the Mexican *mylotes* subspecies and the South American *arriphus* form of this species. There are also other South American subspecies (*agathokles* and *antheas*) of *Parides arcas.* For *Parides childrenae,* there is the Central American form, *childrenae,* in addition to the South American form, *oedippus.* The *sadyattes* form of *Parides erithalion* is recorded from Costa Rica and Panama, and there are several South American forms of this species (*zeuxis, cauca,* etc.). Within-species variation in *Parides* may be due to unstable evolutionary processes that represent recent splits of species into several subspecies and perhaps has little bearing on mimicry. Variations seen in local populations are insufficient to make the species appear "polymorphic" to potential predators, since all forms within species appear similar. Directional selection on the one hand attributing greater fitness to individuals possessing an extreme size, and stabilizing selection on the other hand, in which individuals in the modal size classes have greater fitness, are two forces that could account for observed size distributions which are independent of age effects in an animal population. Different sympatric species, even those closely related, may be expected to exhibit varying amounts of such selective effects due to differences in genetic make-up and slight differences in actual selective pressures. Sex-related color variation among males within a population could be a result of local selective forces that are counteracted with gene flow, mechanisms that account for the existence of geographical forms (clines) in butterfly populations (Lucas 1969). The variation encountered within *Parides* represents different selective pressures than those for other polymorphic tropical butterflies and serving as models in mimicry complexes (e.g., Turner and Crane 1962).

A quantitative study on mimicry complexes in the tropics not dealing with papilionids, (Young 1971), discusses the mimetic interactions between two other tropical papilionids, *Battus polydamus polydamus* L. and *Battus belus varus* Kollar in Costa Rica. At least one of these species, *Battus polydamus,* feeds during larval life upon *Aristolochia* (Aristolochiaceae) and although foodplant records are not yet available for *Battus belus,* it is likely that they also feed on *Aristolochia* (Young in prep.). Species of at least two other genera in the Papilioninae, *Parides* and *Troides,* are also known to feed on *Aristolochia,* and due to the high alkaloid content of the leaves of these vines (Willaman and Schubert 1961), the butterflies of these and other genera of the tribe Troidini have been called the "pharmacophagus" swallowtails (Seitz 1924) or "Aristolochia swallowtails." Of the eight genera comprising the Troidini which are represented both in the New and Old World tropics (except Africa) (Seitz 1924), most species feed on the Aristolochiaceae but with individual species also recorded from distantly related plant groups such as Rutaceae, Menispermaceae, Nepenthaceae, and Piperaceae (Ehrlich and Raven 1964). The Aristolochiaceae comprise the major foodplants of these butterflies and the vines have their greatest distribution and diversification within the Old and New World tropics (Good 1947; Pfeifer 1966). At least three of the species of *Parides* studied here oviposited on various species of *Aristolochia*. It is assumed that all of the species discussed in this paper are distasteful and could act as effective models against avian predation; furthermore, their co-occurrence on a regular basis at flowers in a tropical rain forest constitutes an effective Müllerian mimicry association. This assumption is based on laboratory data showing that one species of *Parides* (*Parides neophilus parianus*) is very distasteful to Blue Jays (Brower and Brower 1964), and the larvae of this species feed on *Aristolochia* sp. in Trinidad. While there is no comparable data available on mimetic associations of *Parides neophilus* in natural populations, it is assumed that such a species would be avoided by birds as a preferred food source.

While this study focused upon mimetic interactions among species of *Parides* butterflies at feeding sites, additional observations were made on mimetic interactions with other species, namely: *Papilio anchisiades idaeus*, F., an unidentified *Papilio*, and *Heliconius doris transiens* Stgr. (Heliconiinae). Both sexes of these species appear similar to female *Parides* and both sexes of *Parides erithalion* may interact mimetically with *Papilio anchisiades*. There probably exists little mimetic interaction of any *Parides* species with these butterflies, while effective mimetic relationships among males are maintained within localized *Parides* complexes.

OBSERVATIONS

During the period September–November 1968, various species of *Parides* butterflies, of the "red and black" variety, were regular visitors at the red flowers of a small tree, *Hamelia patens* (Rubiaceae) which is widely and commonly scattered along the edges of primary-growth tropical rain forest in the lowlands of northeastern Costa Rica. Finca La Selva, a 1300-acre tract of forest owned by The Organization for Tropical Studies, Inc., and situated on the confluence of two rivers, the Rio Sarapiqui and the Rio Puerto Viejo, was the study area. It is located about 2 miles south of the village of Puerto Viejo de Sarapiqui (10° 26′ N, 83°59′ W; 89 m elev.) in the Heredia Province of Costa Rica. The general vegetation of this region is "premontane tropical wet forest" (Holdridge 1967), represented a climatic region characterized by a long wet season and short, but highly variable (in intensity and duration) dry season ("verano") between January and March each year. Although the dry season is characterized by a reduction in rainfall in this region of Costa Rica, the "1969 dry season" was unusually dry, while the "1970 dry season" (not shown) was similar to the 10-year average. (Fig. 1). The 1969 dry season was characterized by less rain and was 2.5 months longer. It was assumed that the rainfall pattern (measured) at Puerto Viejo was similar to that at Finca La Selva (hereafter referred to as "La Selva"), without major departures. Only fragmentary rainfall data (Allen M. Young, personal communication) were available from La Selva, but when inspected, these agreed with trends seen in the monitored Puerto Viejo rainfall.

Hamelia patens is a tropical tree species that blooms continually at La Selva (Gordon Frankie, personal communications), despite the dry season. Thus, it represents a consistently available source of nutrients for various kinds of insects that forage at its flowers for nectar. Individual trees, 10–15 feet high, bloom throughout the year and facilitate the study of butterfly activity. Insects may be readily observed at close range. It is easy to capture (net) several species of butterflies visiting *Hamelia* flowers, mark them with a light-weight enamel-base fast-drying paint ("Flo-Paque"), and release them within a few minutes after capture. At La Selva, various species of *Parides* butterflies fed almost exclusively at *Hamelia* flowers at this level in the forest. At a different locality in northeastern Costa Rica, near San Miguel de Sarapiqui (also premontane tropical wet forest), at least one species of *Parides* (*Parides mycale*) is a frequent visitor at flowers of *Stachytarpheta jamaicensis* (Verbenaceae) (Allen M. Young, personal observations), but at La Selva, barring gross sampling error, neither this species nor others forage at flowers other than *Hamelia* at the understory level in the forest. Such foraging is consistent throughout the year, although there are seasonal changes in abundance of adults of each species of *Parides* at *Hamelia.*

During early January 1969, two widely-separated and heavily-blooming *Hamelia patens* trees (of comparable size) were selected as study sites for a long-term capture-mark-resight program involving all species and all individuals per species of *Parides* butterflies seen visiting the flowers on these trees. The study basically consisted of observing on several days each month the relative numbers of each species of *Parides* seen at each of these two "feeding sites" at La Selva. The first *Hamelia* tree used for these observations (Study Site 1) was located in dense, old second-growth vegetation about 30 feet from the north bank of the Quebrada El Sura, and about 40 feet from the left side of the "El Sura Trail." It was a 3-minute walk from the field station facility. The vegetation surrounding this blooming *Hamelia patens* tree was extremely dense, and consisted of a large stand of *Urera elata* (Urticaceve) plants 5–8 feet tall covered with various young vines, including *Aristolochia* spp., a known foodplant for *Parides* (Seitz 1924). From the trail leading to the stream, this study site was almost invisible. The second *Hamelia* tree (Study Site 2) was located about 500 meters west of Study Site 1 and about 20 feet from the west side of the Quebrada

TABLE 1. Numbers of individuals of the butterfly species in a *Parides* mimicry complex visiting regularly at flowers of the tree, *Hamelia patens* ("Study Site 1") on Finca La Selva, Heredia Province, Costa Rica, 14 January 1969–19 March 1970 (14 months).

		Numbers of marked and unmarked (parentheses) butterflies seen within 4–6 hours on a given day				
Dates	No. Samples	*Parides mycale*	*Parides mylotes*	*Parides childrenae*	*Papilio anchisiades*	*Papilio* sp.
14–27 Jan '69	6	8 (0)	8 (0)	2 (0)	0 (4)	1 (0)
10–18 Feb '69	5	8 (0)	8 (0)	2 (2)	0 (2)	1 (0)
12–20 Mar '69	7	6 (0)	8 (0)	4 (0)	1 (5)	1 (0)
3–11 Apr '69	8	6 (2)	7 (1)	4 (0)	0 (2)	0 (0)
16–22 May '69	8	8 (2)	8 (0)	4 (2)	0 (3)	0 (0)
10–19 June '69	8	10 (0)	8 (0)	3 (1)	0 (0)	0 (0)
5–13 July '69	7	10 (3)	6 (0)	4 (1)	0 (2)	1 (0)
18–26 Aug '69	6	7 (2)	6 (3)	4 (0)	1 (1)	1 (2)
7–15 Sept '69	7	9 (1)	8 (1)	4 (0)	2 (0)	2 (0)
11–19 Oct '69	7	10 (0)	9 (0)	4 (2)	0 (4)	1 (0)
15–23 Nov '69	7	10 (3)	7 (0)	6 (0)	0 (1)	1 (0)
18–25 Jan '70	6	8 (0)	7 (0)	6 (0)	0 (1)	0 (0)
10–14 Feb '70	5	8 (0)	7 (0)	6 (2)	0 (2)	0 (0)
11–12 Mar '70	2	7 (1)	7 (1)	8 (0)	0 (0)	0 (0)

Leonel. It was situated close to primary-growth rain forest where a small cacao (*Theobroma cacao*) grove filled a thin strip of land bordering the Rio Puerto Viejo (north of Study Site 2). Large patches of young second-growth vegetation were intermingled with this cacao grove. The two study sites, separated by several hundred meters of jungle, were visited regularly by various species of *Parides* butterflies. On the ventral surface of the hindwings a large dot of paint was applied. Sex differences and wing condition were recorded by coded markings. From these records it was possible to estimate monthly trends in adult numbers within each species at each feeding site, and to observe trends in adult survivorship, both from mortality associated with old age and from predation. It was assumed that old and worn individuals that "disappeared" from a population had died from old age and were not killed by birds or had not migrated from the area. Such assumptions were justified by concomittant trends in residentiality of individuals observed, and from the low frequency of beak-marks seen on adults. Observations were made on activity of *Parides* at each *Hamelia* tree on several days each month, usually between 8:30 A.M. and 3:00 P.M. (C.S.T.). Occasionally the observation period extended to 6:00 P.M. in order to assess diurnal activity patterns in each species with respect to foraging. The assumption was also made that each of the two blooming *Hamelia* trees provided the major nutrient source for the *Parides* butterflies seen visiting them regularly. This assumption appears justified since individuals (especially males) of each species were residential and did not seek other food sources in the habitat. Usually, a given feeding site was observed for 3–6 successive days each month at La Selva, although there were a few times when this schedule was modified.

Table 2. Numbers of individuals of the butterfly species in a *Parides* mimicry complex visiting regularly at flowers of the tree, *Hamelia patens* ("Study Site 2")[a] on Finca La Selva, Heredia Province, Costa Rica, 3 March 1969–20 April 1970 (12 months).

Dates	No. Samples	Numbers of marked and unmarked (parentheses) butterflies seen within 4–6 hours on a given day				
		Parides mycale	*Parides mylotes*	*Parides childrenae*	*Papilio anchisiades*	*Papilio* sp.
3–9 Mar '69	5	6 (0)	5 (1)	3 (0)	1 (0)	0 (0)
20–24 Apr '69	4	6 (0)	5 (0)	3 (0)	1 (3)	0 (0)
25–29 May '69	4	5 (2)	4 (2)	2 (0)	0 (0)	0 (2)
17–23 June '69	5	7 (0)	6 (1)	0 (0)	0 (3)	0 (1)
14–19 July '69	4	7 (1)	7 (0)	0 (4)	1 (2)	1 (0)
17–23 Sept '69	5	8 (2)	7 (0)	4 (0)	0 (0)	1 (0)
7–10 Oct '69	2	10 (0)	7 (3)	3 (1)	0 (0)	0 (1)
11–14 Nov '69	3	9 (0)	10 (1)	4 (1)	1 (2)	0 (0)
26–30 Jan '70	4	9 (2)	11 (0)	5 (0)	0 (0)	2 (0)
16–21 Feb '70	4	11 (0)	10 (0)	5 (0)	0 (0)	0 (0)
21–25 Mar '70	4	10 (0)	9 (1)	5 (0)	0 (1)	0 (0)
28–30 Apr '70	2	9 (0)	10 (0)	3 (1)	0 (0)	0 (2)

[a] This study site consisted of a small group of blooming *Hamelia patens* trees located about ½ mile from Study Site 1, and in the same type of tropical second-growth vegetation.

Observations were made at ground level using binoculars, although binoculars were not always necessary due to the closeness with which one may approach these feeding butterflies. Unmarked individuals that appeared at each site after the study was begun were captured, marked according to species, sex and individual number, and released at the same spot. Other species that appeared to resemble *Parides* were also netted, marked and released using a different coding system. The marking technique did not appear to interfere with the butterflies normal activity and apparently marked individuals were not injured. Observations initiated during January 1969 were continued on a monthly basis until April 1970. Observations at Study Site 2 were initiated in March 1969. The period of observation at each study site was 14 months for Study Site 1 and 12 months for Study Site 2 with no data obtained during the month of December for both sites, and the month of August 1969 for Study Site 2. On several occasions each month, less regular observations were made on courtship behavior, oviposition, and larval behavior.

POPULATION STRUCTURES AND MIMETIC INTERACTIONS

From January 1969 through March 1970, adults of *Parides mycale*, *Parides mylotes*, and *Parides childrenae* were regular foragers at the flowers of both *Hamelia* trees, and monthly numbers of adults of each of these species are summarized in Tables 1 and 2. Despite the continuous flowering of *Hamelia* throughout the dry seasons in 1969 and 1970 at La Selva adult numbers of all species of *Parides* dwindled during the early part of these periods (January, February). There was no recruitment of teneral adults to the foraging male populations and the

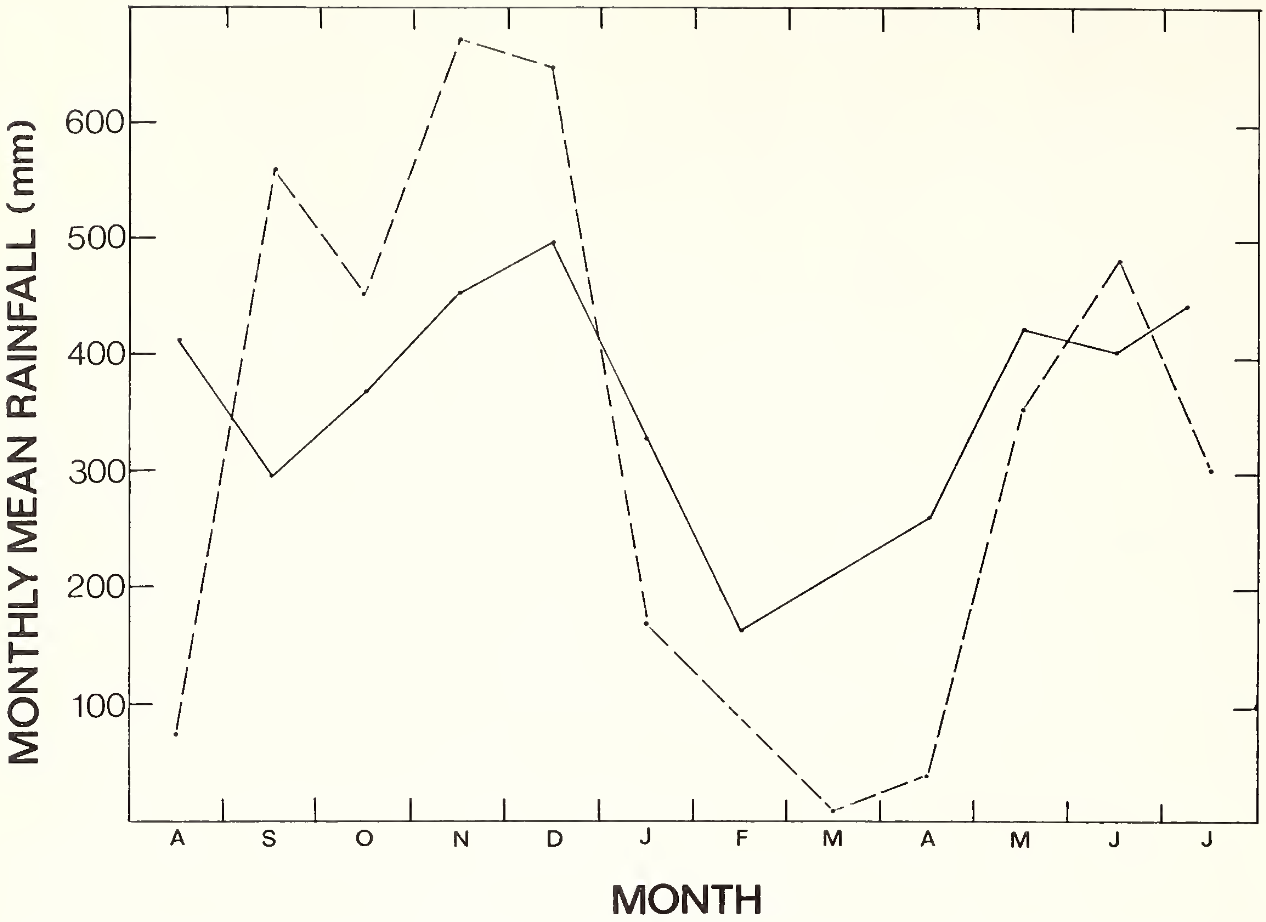

Fig. 1. Seasonal pattern of rainfall at Puerto Viejo, Heredia province, Costa Rica. Solid line–ten year monthly averages; broken line–1969 rainfall pattern. Data courtesy of Servicio Meteorologico de Costa Rica.

precise reasons for these declines are not known. There may be seasonal effects on larval development in which larvae develop more slowly or enter a diapause period until the end of the dry season. Such larval behavior has recently been observed for *Morpho peleides* (Morphinae) in El Salvador, in which fourth-instar larvae become quiescent for about 30 days during the dry season, and complete development (there are 5 instars) only with the onset of the wet season (Alberto Muyshondt, personal communications). Whether or not similar behavior exists for other species of tropical butterflies is not known at the present time. Data concerning monthly occurrences of *Parides erithalion* are excluded here since adult numbers were extremely low (1–3 individuals seen at a *Hamelia* tree on an irregular, sporadic basis) and there were usually several days each month when no adults were seen at each feeding site. The remaining species of *Parides* occur regularly at both feeding sites during the study periods (Tables 1 and 2), and one species, *Parides childrenae*, was consistently lowest in adult numbers each month. While admittedly we are dealing with low population densities for all species, *Parides childrenae* was consistently the least abundant species in the two mimicry complexes in question. Being dissimilar in appearance from both subspecies of *Parides arcas*, selective

Table 3. Sex ratios of butterfly species in a *Parides* mimicry complex visiting regularly at flowers of the tree, *Hamelia patens*, Study Site 1, in a lowland tropical wet forest in northeastern Costa Rica (Finca La Selva, Heredia Province), January 1969–March 1970.

		Numbers of Marked Individuals by Sex								
		Parides mycale			*Parides mylotes*			*Parides childrenae*		
Months	N[a]	♀♀	♂♂	T	♀♀	♂♂	T	♀♀	♂♂	T
Jan '69	6	2	6	8	3	5	8	0	2	2
Feb.	5	2	7	9	3	5	8	1	3	4
Mar	7	1	5	6	3	5	8	1	3	4
Apr	8	3	5	8	2	5	7	1	3	4
May	6	2	8	10	2	6	8	1	5	6
June	8	2	8	10	2	6	8	0	4	4
July	7	3	9	12	1	5	6	0	5	5
Aug	6	2	7	9	1	5	6	0	4	4
Sept	7	2	8	10	2	7	9	0	4	4
Oct	7	2	8	10	2	7	9	2	4	6
Nov	7	3	10	13	1	6	7	2	4	6
Jan '70	6	2	7	9	2	7	9	2	4	6
Feb	5	1	8	9	3	7	10	3	5	8
Mar	5	3	5	8	4	4	8	2	6	8

[a] N is the number of days of observation each month when butterfly activity was highest at this nectar source.

factors may operate to keep the numbers of *Parides childrenae* lower than *Parides arcas* in order to maintain an effective Müllerian mimetic interaction. These species are undoubtedly distasteful to birds and the less abundant any departure from the more frequent forms in the complex, the more likely the dissimilar form will escape attempted predatory attacks. At low population sizes in tropical butterflies, attempted predatory attacks by birds could result in local extinctions of species, even species involved in Müllerian mimicry complexes. A "successful" attack in small populations characterized by individuals of low vagility, could lead to local extinction. It has been demonstrated that small populations can be subjected to random extinction (Wilson and MacArthur 1967), and superimposed biotic effects such as predation could hasten this.

While adult populations of *Parides* at the two feeding sites were small, they consisted predominantly of males (tables 3 and 4). Females appeared on a less regular basis than the males. Sometimes for 2–3 successive days marked females of any species (but especially *Parides childrenae*) did not visit a feeding site. There was an apparent number of "residential" females that visited at each feeding site, and presumably these individuals were part of nearby breeding populations. Based on observations made in the immediate vicinity of feeding sites (usually within 200 feet), it was apparent that marked females wander considerable distances away from feeding sites, presumably in search of suitable oviposition sites. At Study Site 1, scattered patches of

Table 4. Sex ratio of butterfly species in a *Parides* mimicry complex visiting regularly at flowers of the tree, *Hamelia patens*, Study Site 2, in a lowland tropical wet forest in northeastern Costa Rica (Finca La Selva, Heredia Province) March 1969–April 1970.

		Numbers of Marked Individuals by Sex								
		Parides mycale			*Parides mylotes*			*Parides childrenae*		
Months	N[a]	♀♀	♂♂	T	♀♀	♂♂	T	♀♀	♂♂	T
Mar '69	5	2	4	6	1	5	6	0	3	3
Apr	4	2	4	6	1	4	5	0	3	3
May	4	1	5	6	1	5	6	0	2	2
June	5	2	5	7	2	5	7	0	0	0
July	4	2	5	7	2	5	7	1	3	4
Sept	5	3	5	8	2	5	7	1	3	4
Oct	2	3	7	10	3	7	10	2	2	4
Nov	3	2	7	10	3	8	11	2	3	5
Jan '70	4	2	9	11	3	8	11	2	3	5
Feb	4	2	9	11	3	7	10	2	3	5
Mar	4	2	8	10	2	7	9	2	3	5
Apr	4	2	7	9	2	8	10	1	3	4

[a] N is the number of days of observation each month when butterfly activity was highest ("sunniest days") at this nectar source.

Aristolochia spp. were present and females of *Parides mycale* and *Parides mylotes* were seen occasionally resting on vegetation associated with these vines. Sex ratios at feeding sites, sex ratios of adults emerging from egg clusters, and degree of residentiality of males versus females, suggest that female *Parides* were more vagile than males. Related to the apparent irregular occurrence of females of these species of *Parides* at the two feeding sites studied were the concomitant irregular visitations of potential mimics of these butterflies. *Papilio anchisiades* and *Papilio* sp. were infrequent visitors at these feeding sites, and resightings of previously-marked individuals were low (tables 1–2). An unrelated form, *Heliconius doris* is also seen at widely scattered intervals (days of observation) each month, and marked individuals were rarely resighted, even within 5 days after marking. Such observations on potential mimics of female *Parides*, and the irregular visitation patterns of female *Parides* at feeding sites, suggests that mimetic interactions at feeding sites may be restricted to Müllerian associations only among males of various species of *Parides*. The male associations among *Parides* butterflies appeared most stable at feeding sites, in terms of the regularity (daily and monthly) of individual male visitations at flowers. Little is known about time for learning by would-be vertebrate predators in order to associate distastefulness with color in natural populations of tropical butterflies and therefore little can be said about the effectiveness of mimicry involving *Parides* females at feeding sites where males are regular foragers. It was the male component of each species-population that was maintained at feeding sites over long

Table 5. Diurnal pattern of courtship[a], egg-laying, and feeding in sympatric, local populations of *Parides mycale*, *Parides mylotes*, and *Parides childrenae*, at Finca La Selva, a lowland tropical wet forest site in northeastern Costa Rica.

	Mean Number of Adults[b] Seen Hourly for Different Categories of Activities[c]								
	Parides mycale			*Parides mylotes*			*Parides childrenae*		
Time (C.S.T.)	Feeding	Courtship	Oviposition	Feeding	Courtship	Oviposition	Feeding	Courtship	Oviposition
A.M.									
8:00–9:00	1	0	0	0	0	0	0	0	0
9:00–10:00	3	0	0	3	0	0	1	0	0
10:00–11:00	9	7	0	8	8	0	4	0	0
11:00–12:00	9	10	0	10	11	0	4	6	0
P.M.									
12:00–1:00	5	6	0	8	7	4	5	4	0
1:00–2:00	7	0	10	5	1	9	3	2	5
2:00–3:00	6	0	7	2	0	6	2	0	8
3:00–4:00	2	0	9	2	0	8	0	0	4
4:00–5:00	1	0	0	0	0	0	0	0	0
5:00–6:00	0	0	0	0	0	0	0	0	0

[a] Defined here as "directed, aerial pursuits of females by males in vegetation near feeding site"—see text for elaboration; given are the numbers of such pursuits witnessed.

[b] Data combined for the 2 study sites, with hourly means calculated over entire study period (using March 1969–March 1970 period).

one feeding site. Several species of male *Parides* may be present at a specific feeding site on a given day, and the temporal persistence of such interactions periods of time. It appears that much of the irregularity of foraging by these individuals at *Hamelia* was due to flying activity associated with oviposition (searching for oviposition sites). Female *Parides* and mimics such as *Papilio anchisiades*, *Papilio* sp., and *Heliconius doris* moved around in the forest far more than male *Parides*, as judged from the marking program, and effective mimetic associations among such individuals may not be established at any among species over long periods of time may provide the basis for an effective Müllerian mimicry complex at the feeding site. Males of *Parides mylotes, Parides mycale* and *Parides childrenae* were active at feeding sites during the same hours on sunny days at La Selva (table 5), and females of all three species were seen ovipositing during the afternoon hours. The few observations available on tandem pairs indicate that courtship occurs for all three species at the same times during the day (table 5). Cross-subspecies copulations have not been observed for *Parides mycale* and *Parides mylotes*. The common activity period for males of these species in regard to foraging at *Hamelia* flowers would serve to reinforce mimetic association among these species. Rothschild (1964) points out that selection should favor similar feeding periods for species involved in Müllerian mimicry complexes. Selection should favor similar courtship and oviposition periods in these species, since

TABLE 6. Numbers of adult *Parides*[a] bearing evidence of bird attack (beak-marks and wing damage) in mimicry complexes visting regularly at flowers of two *Hamelia patens* trees (Study Sites 1 and 2) at Finca La Selva, Heredia Province, Costa Rica. Data combined for the two sites.

	Parides mycale		*Parides mylotes*		*Parides childrenae*	
Months	Total	Damaged	Total	Damaged	Total	Damaged
Jan[a]	8	1	8	0	2	0
Feb	9	1	8	0	4	0
Mar	12	2	14	2	7	0
Apr	14	2	13	2	7	0
May	17	3	14	1	8	2
June	17	2	15	2	4	1
July	21	4	13	4	9	0
Aug	9	1	9	0	4	0
Sept	20	2	16	3	8	1
Oct	19	0	19	1	10	2
Nov	22	3	18	0	12	1
Jan	19	1	20	2	11	3
Feb	20	0	20	1	13	1
Mar	18	2	18	3	13	0
Apr	9	0	10	1	4	0

[a] Combined data for both sites, except Jan, Feb, and August 1969, and April 1970, when data from only one feeding site is available.

such activities determine, in part, the local survivorship of the species at low population numbers in the forest.

Whether or not effective Müllerian mimicry is actually operating between *Parides* species at feeding sites or merely each species displays a warning coloration that, devoid of mimetic effects, can induce a "fright" response in

TABLE 7. Age-distribution in an adult male population of *Parides mycale*, based on examinations of marked individuals over several successive months at a feeding site (No. 1), flowers of a *Hamelia patens* tree in a lowland tropical wet forest (Finca La Selva, Heredia Province) in northeastern Costa Rica.

		Relative Numbers in Various Age-classes				
Months	N	"Tenerals" (1–12 days)	"Young" (10–25 days)	"Middle Age" (1–3 mo.)	"Old" (3–5 mo.)	"Very Old" (5–7 mo.)
Jan	3	0	0	3	4	1
Feb	4	0	0	3	3	2
Mar	4	0	0	1	5	0
Apr	5	1	1	1	3	2
May	5	2	2	1	3	2
June	4	0	3	2	2	3
July	4	3	1	3	3	3
Aug	4	2	3	3	1	0
Sept	5	1	5	1	2	1
Oct	5	0	2	4	2	2
Nov	4	3	0	5	3	2
Jan	4	0	1	6	1	0
Feb	4	0	0	5	3	0
Mar	3	1	0	3	3	1

Table 8. Age-distribution in an adult male population of *Parides mylotes*, based on examinations of marked individuals over several successive months at a feeding site (No. 1), flowers of a *Hamelia patens* tree in a lowland tropical wet forest (Finca La Selva, Heredia Province) in northeastern Costa Rica.

		Relative Numbers in Various Age-classes				
Months	N	"Tenerals" (1–12 days)	"Young" (10–25 days)	"Middle Age" (1–3 mo.)	"Old" (3–5 mo.)	"Very Old" (5–7 mo.)
Jan	3	0	0	5	2	1
Feb	4	0	0	3	4	1
Mar	4	0	0	3	2	3
Apr	5	1	0	2	3	2
May	5	0	1	2	3	2
June	4	0	0	1	4	3
July	4	0	0	1	4	1
Aug	4	3	0	0	5	1
Sept	5	1	3	0	5	0
Oct	5	0	2	2	3	2
Nov	4	0	1	2	4	0
Jan	4	0	0	1	5	1
Feb	4	0	0	0	4	3
Mar	3	1	0	0	3	4

would-be avian predators (Coppinger 1969) was not be discernible in this study, although it was apparent that individual survivorship from such mortality is high (table 6). Adults, presumably damaged by bird attacks, were retrieved from populations at La Selva. The incidence of such nonseasonal mortality within a localized "group" of males visiting a feeding site is very low. Adults "disappear" from a feeding site when they become "old" or "very old" (tables 7–9), and presumably this represents deaths due

Table 9. Age-distribution in an adult male population of *Parides childrenae*, based on examinations of marked individuals over several successive months at a feeding site (No. 1), flowers of a *Hamelia patens* tree, in a lowland tropical wet forest (Finca La Selva, Heredia Province) in northeastern Costa Rica.

		Relative Numbers in Various Age-classes			
Months	N	"Tenerals" (1–20 days)	"Young" (14–40 days)	"Middle Age" (2–4 months)	"Old" (4–7 months)
Jan	3	0	0	2	0
Feb	4	2	0	2	0
Mar	4	0	2	0	2
Apr	5	0	0	2	2
May	5	2	0	1	3
June	4	1	2	1	0
July	4	1	1	3	0
Aug	4	0	1	2	1
Sept	5	0	0	2	2
Oct	5	2	0	1	3
Nov	4	0	2	0	4
Jan	4	0	1	1	4
Feb	4	2	0	2	4
Mar	3	0	0	4	4

to old age rather than predation. Younger adult males (tables 7–9) seldom disappeared from populations associated regularly with *Hamelia* flowers. Based on changes wing condition, estimation of the age-structure of a male *Parides* population associated with a given feeding site can be established. although more precise bracketing of age classes was unfeasible under field conditions. It is possible to conclude (tables 7–9) that individual males (and presumably females) are long-lived (a maximum of 6–7 months) obviously avoiding predation. Adult population turnover was generally low at feeding sites (tables 1–2) and most unmarked males seen during the study periods were "fresh" in wing condition, apparently recently emerged from pupae. No major emigration of older adults to these feeding sites from other places in the forest was observed and presumably the adult male populations regularly associated with different feeding sites (*Hamelia* trees) represented a component localized breeding population of high residentiality. Adult male populations at La Selva were small, localized, and had low rates of turnover. Individual male *Parides* movements possessed low vagility in terms of their daily activities.

Such population "cohesiveness" in male *Parides* feeding associations at *Hamelia* may in part be accounted for in terms of butterfly behavior at these sites in the jungle. From observations on marked males, virtually every one of these individuals within species perched regularly close to the actual *Hamelia* tree. By careful searching the perching sites for all three species of males in the second-growth vegetation associated with each feeding site were located. Day-to-day perching sites for males when not feeding were variable, yet each male on a given day repeatedly returned to the same plant for perching. Resting males intercepted passing males and females of any *Parides* species, but the significance of this behavior is not clear at this time. Homing ability of individual males was well developed. Aggressive assaults exclusively within species have not been observed. Males flew off with the passing of either sex for any species in similar flight behavior and appeared to "chase" the passing butterfly without contacting it. Such pursuit movements were typically terminated within several seconds by return of the "challenger" either to the perching site or to feeding at *Hamelia* flowers.

Little is known about larval mortality and survivorship through the pupal stage in natural populations. Such mortality will have to be estimated for observed local adult (male) densities at feeding sites. Lack of comparable numbers of females at feeding sites was probably related to searching behavior of oviposition sites. The observed aberrant sex ratios at feeding sites seen in this study cannot be explained in terms of density-related dispersal mechanisms in which females respond to increasing population densities by migrating to new habitats for reproduction (Shapiro 1970). At low population densities, presumably fertilized females disperse from centers of male activity (feeding sites and immediate vicinity), cruising through the jungle in search of suitable *Aristolochia* vines for oviposition.

Dispersal behavior by females may be induced by behavior of males at feeding sites. Preliminary observations suggest that males will chase females in the immediate vicinity of feeding sites and while such "pursuit" behavior is not density-related (Shapiro 1970), it may cause females to leave the area. Selection favors the dispersal of females away from places of high male concentration to ensure oviposition with minimal loss of energy and time in post-mating interactions with males. In a few instances in which males were observed chasing females of their own species, the chase led away from the feeding site. Perhaps the initial phases of courtship behavior in these butterflies take place at feeding sites although copulating pairs were not observed at feeding sites. It is also possible that adult males are territorial at feeding sites, although further, detailed observations on male-male interactions within species must be carried out to determine and characterize such behavior.

From the observations summarized here on relative abundances of adult males, it is apparent that the feeding behavior among different *Parides* at common foraging sites, is specialized and accounts, in part, for the localized distributions of adult *Parides* in lowland tropical rain forests. The apparent lack of seasonal changes in this behavior for these butterflies represents a "specialization of niche" that is usually characterized for organisms associated with the non-seasonal wet tropics (e.g., Slobodkin 1970).

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Studies on Arthropod Fauna of Alfalfa Insect Feeding on Hylemya Flies (Diptera: Anthomyiidae) Killed by a Phycomycosis[1]

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Abstract: Observations were made at Ithaca, New York of insect feeding on the seedcorn maggot, *Hylemya platura,* and *H. florilega* (Diptera: Anthomyiidae) killed by a phycomycosis caused by *Entomophthora muscae.* Five species of normally plant-feeding Miridae and six species of predators of alfalfa insects were found to utilize cadavers as a source of food. The mirids *Plagiognathus politus* and *Lygus lineolaris* fed most commonly on the dead flies. It is suggested that the predaceous species generally do not recognize cadavers as a potential food source and that this food source might form a significant portion of the diet of *P. politus* and *L. lineolaris* during times of host plant deterioration.

INTRODUCTION

During a study of the arthropod fauna of alfalfa, observations were made in 1967 of insect feeding on *Hylemya* spp.[3] (Diptera: Anthomyiidae) killed by a phycomycosis caused by *Entomophthora muscae* (Cohn). *E. muscae* is known to infect *Hylemya* spp. (Miller and McClanahan, 1959), and cadavers have been collected previously on alfalfa (Steinhaus and Marsh, 1962). Since there was no record of insect feeding on cadavers of *Hylemya* flies, observations were made from 1967 to 1969 at Cornell University's Savage Farm, Ithaca, New York, to identify the species feeding on flies and the frequency of this feeding behavior.

The seedcorn maggot, *H. platura,* and *H. florilega* appear to have similar habits (Miles, 1948) with both exhibiting a preference for feeding on sprouting seeds, particularly those of beans, peas, corn, and potatoes (Reid, 1940; Miles, 1948). Alfalfa may at times be attacked (Reid, 1940; Miller and McClanahan, 1960).

E. muscae is a well-known parasite on Diptera, especially large forms (Thaxter, 1888). Conidiophores of infected flies penetrate only the tergites, giving a striped appearance. Frequently the flies are found attached to inflorescences (Gustafsson, 1965). High humidity and cool temperatures have been suggested

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[3] *Hylemya platura* (Meigen) (=*cilicrura* Rondani) and *H. florilega* (Zetterstedt) (=*liturata* Meigen = *trichodactyla* Rondani).

Table 1. Insects on alfalfa observed to feed on *Hylemya* flies killed by the fungus *Entomophthora muscae.*

Species	Stage	No. Observations
HEMIPTERA		
Miridae		
Adelphocoris lineolatus (Goeze)	Adult	2
	Nymph	1
Lygus lineolaris (Beauvois)	Adult	25
Neurocolpus nubilis (Say)	Adult	1
Plagiognathus chrysanthemi (Wolff)	Adult	2
P. politus Uhler	Adult	78
Nabidae		
Nabis alternatus Parshley	Adult	1
N. americoferus Carayon	Adult	2
COLEOPTERA		
Staphylinidae		
Philonthus sp.	Adult	1
Cantharidae		
Cantharis carolinus Fabricius	Adult	1
Coccinellidae		
Coleomegilla maculata (De Geer)	Adult	3
	Larva	1
Hippodamia convergens (Guerin)	Adult	1

as favoring the incidence of disease (Miller and McClanahan, 1959; Gustafsson, 1965).

RESULTS AND DISCUSSION

In June, 1967, large numbers of *Hylemya* spp. infected with *E. muscae* were found clinging to terminal stems of alfalfa. During June, adults of the mirid *Plagiognathus politus* Uhler were observed with proboscises inserted in dead *Hylemya* flies, frequently in the eyes of the flies. A 30 minute search in alfalfa on 11 July 1967, revealed more than 40 instances of feeding on cadavers by *P. politus.*

In addition to *P. politus* several other common phytophagous mirids on alfalfa, as well as several important predators of alfalfa insects, were found to utilize dead flies as a source of food. Table 1 lists the species found to feed on *Hylemya* flies and the number of times feeding was observed.

It is impossible to assess the amount of energy derived from feeding on dead flies. For the mirids *Adelphocoris lineolatus* (Goeze) and *P. chrysanthemi* (Wolff) the amount must be small, but perhaps could be significant when the alfalfa is of poor quality because of disease, insect damage, or physiological change in the host plant. The energy obtained from feeding on cadavers by the predaceous species appears also to be small. Predators such as coccinellids and nabids typically attack moving prey. Perhaps the cadavers were not generally recognized as a potential food source. These predators were found to be infrequent feeders on another stationary food source on alfalfa, mummified pea aphids containing the late stages of aphidiine parasites (Wheeler et al., 1968). With *P. politus* and *Lygus lineolaris* (Beauvois) the habit of feeding on cadavers of *Hylemya* spp. appears to be well developed. These normally plant-feeding mirids were also the most common predators on mummified pea aphids (Wheeler et al., 1968). In times of host plant deterioration this food source might form a significant portion of the diet of *P. politus* and *L. lineolaris*.

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Proceedings of the New York Entomological Society

(Meetings held in Room 129 of the American Museum of Natural History unless otherwise indicated).

Meeting of October 6, 1970

President Lee Herman presided; 18 members and 5 guests present. Proposed for Active Membership were: Mr. Charles Spielman of Chicago, Illinois, and Mr. George V. Kirk of Newark, Delaware.

PROGRAM. **Some Recent Studies on the Ecology and Behavior of Carrion Beetles.** Dr. Paul Shubeck, of the Department of Biology, Montclair State College studied carrion beetles found in the Hutcheson Memorial Forest, East Millstone, New Jersey. He found the following families of coleoptera on carrion: Silphidae, Leptodiridae, Histeridae and Staphylinidae.

Dr. Shubeck showed kodachromes of these beetles as well as the areas studied and the trapping methods used. He found that beyond a distance of 1 meter from a trap containing carrion, the orientation of the beetle was "random" in reference to eventually finding the carrion. He also presented data on diurnal and nocturnal behavior of the beetles.

The meeting was adjourned at 9:40 P.M.

DANIEL J. SULLIVAN, S.J., *Sec.*

Meeting of October 20, 1970

Vice-president Howard Topoff presided; 18 members and 6 guests were present.

Elected to Active Membership were Mr. Charles Spielman of Illinois and Mr. George V. Kirk of Delaware.

Proposed for Active Membership was Mr. Richard E. Gray of Enfield, New Hampshire.

Dr. Topoff explained that Dr. Harvey Barkey of the State University of Farmingdale, New York had been taken ill. His scheduled talk on "The Ecological Importance of Mites" will be postponed to a later date.

PROGRAM. **Preliminary Studies on the Phylogenetic Relationship Among Lice.** Mr. Frederick Miller showed slides of the scanning electron microscope which he uses in his work and then the tuft and pore organs on the antennae of various species of lice. Because of the magnification achieved it is now possible to include other diagnostic characters besides the traditional ones on the genital and sternal plates as the basis for species description. Mr. Miller feels that there is a strong possibility of a phylogenetic relationship existing between chewing lice being studied in England and the sucking lice being studied by him.

The meeting was adjourned at 9:20 P.M.

DANIEL J. SULLIVAN, S.J., *Sec.*

November 3, 1970—Election Day—No Meeting.

NEW YORK ENTOMOLOGICAL SOCIETY, LXXIX: 228–235. December, 1971.

Meeting of November 17, 1970

President Lee Herman presided; 19 members and 35 guests were present.

Elected to Active membership was Mr. Richard E. Gray of Enfield, New Hampshire.

Proposed for Active Membership was Dr. Howard G. Sengbusch of the State University College at Buffalo, New York.

PROGRAM. **The World of Life.** Dr. Roman Vishniac said that he would show two films in connection with his talk. His interest in the process of evolution has occupied him for a life time and in order to illustrate his studies more effectively, has developed a unique photographic skill of portraying flora and fauna.

While narrating his films he explained the difficulties encountered where the organism is too large for a compound microscope and yet too small for the ordinary camera.

Dr. Vishniac answered questions at the conclusion of his remarks.

The meeting was adjourned at 9:40 P.M.

Daniel J. Sullivan, S.J., *Sec.*

Meeting of December 1, 1970

Vice-president Howard Topoff presided; 10 members and 9 guests were present.

Elected to Active Membership was Dr. Howard G. Sengbusch of the State University College at Bufallo, New York.

Dr. Topoff reminded the membership that at the next meeting, December 15th, there would be a discussion on the proposed changes in the By-Laws of the Society.

PROGRAM. **Spiders of Arizona.** Dr. John Cooke of the American Museum of Natural History studied the spiders in the area of the Southwestern Research Station in Portal, Arizona. He showed many excellent color slides of the insect fauna of the region.

The meeting was adjourned at 9:20 P.M.

Daniel J. Sullivan, S.J., *Sec.*

Meeting of December 15, 1970

Vice-president Howard Topoff presided; 16 members and 8 guests were present.

Proposed for Active Membership by Mr. J. Huberman were: Mr. Thomas G. Dow of Grandview, New York and Mr. Kenneth McNichol of Palisades, New York.

Proposed for Student Membership was Miss Gaye L. Williams of Bowie, Maryland.

Dr. Topoff led the discussion of the membership concerning changes in the By-laws suggested by the Executive Committee. All of the proposed changes were approved with the exception of the following two sections:

Article V, Section 5 concerned with who may authorize payment for expenses of guest speakers.

Article XII, Section 2 concerned with the Junior Entomological Society.

PROGRAM. **Recent Developments in Mosquito Biology.** Mr. Robert Lake explained that the Department of Entomology of the University of Delaware has had a mosquito control program since 1933. Although slides were shown of the stages of the Anophelines and Culicines, greater stress was placed upon the role of the *Aedes* mosquito in relation to the environment, e.g., salt marsh pools and borders, pitcher plants, tree-holes, rock-pools, cracked hydraulic fill-ins, artificial containers, etc.

From an ecological standpoint Mr. Lake recommended an integrated approach to mosquito control using various available methods plus coordination of wildlife and conservation agencies.

The meeting was adjourned at 10:05 P.M.

DANIEL J. SULLIVAN, S.J., *Sec.*

Meeting of January 5, 1971—The Annual Meeting

President Lee Herman presided: 15 members and 5 guests were present. Dr. Winifred Trakimas, Treasurer, explained that due to the incompleteness of the report from the bank concerned with the up-to-date accumulation of interest in the Society's account, a detailed report will be presented at a later date.

The Nominating Committee, consisting of Dr. Elsie Klots, Dr. John Cooke and Mr. Robert Buckbee, presented the list of candidates for the year 1971 as follows:

President—Lee Herman, Jr.
Vice-president—Howard R. Topoff
Secretary—Daniel J. Sullivan
Asst. Secretary—Betty White
Treasurer—Winifred Trakimas
Asst. Treasurer—Patricia Vaurie

Trustees—Class of 1972	Jerome Rozen, Jr. Frederick Miller
Publication Committee	Alexander B. Klots, Chairman Ahodyha P. Gupta Joan DeWind

There were no further nominations and upon motion made and duly seconded the Secretary was instructed to cast one ballot for the unanimous election of the above mentioned candidates.

Elected to Active Membership were: Mr. Thomas G. Dow of Grandview, New York and Mr. Kenneth McNichol of Palisades, New York.

Miss Gaye L. Williams of Bowie, Maryland was elected to Student Membership.

Sponsored by Mr. J. Huberman, the following were proposed for Active Membership: Dr. John P. Kramer of the Department of Entomology and Limnology, Cornell University, Ithaca, New York and Dr. Louis Handfield of Quebec, Canada. Mr. Robert Buckbee read the following resolution, approved by the Executive Committee:

Be it Resolved:

Over the years many persons have been elected to Honorary Membership in the New York and Brooklyn Societies. The Society now has six living Honorary Members:

Charles P. Alexander
SuZan Swain Firmage
Alexander B. Klots
Rowland R. McElvare
Asher Treat
Harry B. Weiss.

Although some of these are able to be with us with some regularity, others find it impossible, for good reasons, to attend our meetings.

So that all may know that our honoring of these members is not once voted and then forgotten, we think it is proper at this our Annual Meeting on January 5, 1971 to send affectionate greeting to each of these Honorary members; and we record this fact by sending a copy of this Resolution to each of them, and by recording it in our Journal.

That this was read and voted at this meeting, we certify

President Lee Herman
Secretary Daniel J. Sullivan

PROGRAM. **Problems of Urban Pest Control.** Dr. Arthur Brody of the Pioneer Exterminating Company emphasized the difficulties encountered in pest control. The problems are concerned not only with various techniques but especially with the ignorance of the people insofar as cleanliness, use of chemicals, etc. are concerned.

The meeting was adjourned at 9:40 P.M.

Daniel J. Sullivan, S.J., *Sec.*

Meeting of January 19, 1971

President Lee Herman presided; 17 members and 9 guests were present. Elected to Active Membership were Dr. John P. Kramer of the Department of Entomology and Limnology, Cornell University, Ithaca, New York and Dr. Louis Handfield of Quebec, Canada.

At the January 5th, 1971 meeting it was announced that special greetings were being sent to the six living Honorary Members of the Society. Two of these wrote letters of appreciation to the President. The letters from Charles P. Alexander of Amherst, Mass. and Harry B. Weiss of New Brunswick, N.J. were read at the meeting.

PROGRAM. **Ecological Role of Leaf-Cutting Ants.** Dr. Neal Weber of the Department of Biology, Swarthmore College illustrated his talk with color slides. The destructive aspect of their behavior becomes apparent in their competition with man for man's crops and man's domestic animals. However, certain benefits accrue from ant activity—i.e., aeration of the soil, removal of decaying or dead vegetation, turn-over of organic matter, etc. Dr. Weber discussed the relationship between ants and other animals especially the discoveries of various animals found in ant nests such as snakes, beetles, collembola, thysanura and lepidoptera. (An abstract follows).

The meeting was adjourned at 9:25 P.M.

Daniel J. Sullivan, S.J., *Sec.*

THE ECOLOGICAL ROLE OF THE LEAF-CUTTING ANTS, *ACROMYRMEX* AND *ATTA*

The fungus-growing ants with the most populous colonies and with workers of the largest size are the leaf-cutters *Acromyrmex* and *Atta*. Two other genera, *Sericomyrmex* and *Trachymyrmex*, are minor leaf-cutters. The two principal genera are distributed from 44° south latitude in Argentina to southern California and east to Louisiana. Throughout this vast area these ants are often the dominant animals locally. In Brazil they are considered the chief animal pest to agriculture and stock-raising and are the target for disseminating insecticides.

The physical effects on the environment stem from their nests. Some *Atta* nests occupy a volume of soil equivalent to that of a large room. Some species prepare a chamber which they use for refuse. All leaf-cutter ant nests aerate the soil over a considerable area.

The effects on other animals are varied. They serve as a food source for ant-eaters, lizards, toads and birds. In South America snakes frequent their nests and a recent Uruguayan study states that the mound nests are used as incubators for snake eggs. A host of arthropod species are known only from their nests.

They exert their greatest ecological effect on plants. Superficially they appear harmful because of their cutting of leaves of economic plants encouraged by man's monoculture. In nature they forage widely and are an important agent in reducing exuberant plant growth. Even though several species cut only grass and appear to be direct competitors of cattle the grass continues to grow.

Mapping and conservation of their nests is strongly urged in all biological reserves and a complete assessment of their ecological role should be undertaken before they are exterminated over large areas.

Neal A. Weber

Meeting of February 2, 1971

President Lee Herman presided; 19 members and 10 guests were present.

PROGRAM. **Brood Ten of the Periodical Cicadas in New Jersey—1902 and 1970.** Dr. John B. Schmitt of the Department of Entomology, Rutgers the State University, spent a great deal of time searching the literature and visiting the locales of this brood. He explained that the Periodical Cicada is endemic to the United States but is only found east of the Mississippi River. The loud sound made by the males during the mating period seems to serve the purpose of attracting males first which are later followed by females. Of the generations of Brood Ten in this century, those of 1902 and 1970 are of especial interest because of the excellent documentation done by Smith for 1902 in the New Jersey area which provided a parallel for the 1970 survey discussed by Dr. Schmitt. Brood Two which last appeared in 1962 has an entirely different distribution.

The eggs of cicadas are deposited in the terminal branches of trees and Dr. Schmitt showed kodachromes of the slits made by the ovipositing females. After hatching some damage is evident and tree "flagging" can be readily detected. However, the overall damage to the tree in one season is negligible. After the terminal twigs fall to the ground, the nymphs emerge, dig downward and feed on the roots of trees and shrubs for the next 17 years. Brood Ten studied in 1970 should emerge in 1987.

Dr. Schmitt pointed out that there are two major factors that have upset the ecology of the cicada populations: forest fires and suburban land development. The speaker hopes to make a comparative survey of Brood Two which is expected to emerge in 1979. (An abstract follows).

The meeting was adjourned at 9:10 P.M.

Daniel J. Sullivan, S.J., *Sec.*

BROOD X OF THE PERIODICAL CICADAS IN NEW JERSEY, 1902 AND 1970

The last thorough study of the distribution of Brood X of the Periodical Cicadas in New Jersey (*Magicicada* spp.) was made in 1902. Data collected on the distribution of the 1970 emergence indicates a disappearance since 1902 from the following localities: eastern Mercer County, except Princeton; eastern Somerset County; Prospertown-Colliers Mills, Ocean County; Jacobstown-Ellisdale, Burlington County; Cherry Hill Township, Camden County; Salem and Woodstown, Salem County; and Shiloh in Cumberland County. Hitherto-unreported populations were found at Lower Powhatcong, Warren County; Middletown, Monmouth County; and Quinton and Alloway in Salem County. More than 40 populations were found in Hunterdon County, west and south of the South Branch of the Raritan River. Factors in the disappearance of the insect appear to have been the following: destruction of woodlands, forest fires, and urbanization. There was no evidence that pesticides have played any part in the population losses.

J. B. Schmitt

Meeting of February 16, 1971

Vice-president Howard Topoff presided; 15 members and 8 guests were present.

program. **Insect Collecting in Iceland, Colombia and Africa.** Dr. Donald Messersmith of the Department of Entomology, University of Maryland discussed the many unusual circumstances in his collecting of insects in Iceland and Africa. In addition to speaking about insects he also showed many kodachromes of other fauna and the flora of these regions. It was interesting to see the group of Icelandic children who became Dr. Messersmith's eager and productive assistants in collecting insects.

The meeting was adjourned at 9:45 P.M.

Daniel J. Sullivan, S.J., *Sec.*

Meeting of March 2, 1971

President Lee Herman presided; 21 members and 12 guests were present.

program. **Behavior and Neurobiology in Giant Waterbugs.** Dr. Saul Barber, Chairman of the Department of Biology of Lehigh University, Pennsylvania explained that he became interested in the neurobiology of the giant waterbugs while working in the laboratory of Dr. John Pringle of Oxford. He noticed that when he handled them in a certain way the bugs vibrated the anterior part of the abdomen. When he returned to his own laboratory at Lehigh, he concentrated on the muscles that controlled this curious vibration. His electrophysiological studies have thus far revealed that there are two synchronized muscles which are able to contract and relax with unusual speed.

The meeting was adjourned at 9:35 P.M.

Daniel J. Sullivan, S.J., *Sec.*

Meeting of March 16, 1971

President Lee Herman presided; 17 members and 5 guests were present.

The following individuals were proposed for Active Membership: Mrs. Lucia S. Tomkins, New York; Mr. William Pettit, London, England and Mr. Jeffrey N. Stibick of Papua and New Guinea.

Mr. John J. Doria of Brooklyn, New York was proposed for Student Membership.

PROGRAM. **Prey Capture in Backswimmers** (a film) and **The Natural History of Big Bend National Park, Texas.** Dr. Richard Fredrickson of the Deparment of Biology, St. Joseph's College, Philadelphia began his presentation by showing a short film on backswimmers (*Notonecta*). As the film progressed Dr. Fredrickson commented on the various behavioral patterns that were observed: diving and preening, stridulation and reaction to vibrations in the water. To show that the backswimmers reacted to vibrations, prey dropped into the water was quickly captured and eaten. Pieces of string also served as bait into which the backswimmers inserted their beaks.

The second part of the program was concerned with a three week trip in Big Bend National Park with two students. His kodachromes depicted the various life zones and in addition included some flora and fauna from Rocky Mt. National Park.

The meeting was adjourned at 9:40 P.M.

Betty White, *Asst. Sec.*

BOOK REVIEWS

The Life Cycle and Behavior of *Cercoleipus coelonotus* (Acarina: Mesostigmata), Including a Survey of Phoretic Mite Associates of California Scolytidae. Kinn, D. N. University of California Publications in Entomology, Volume 65. Berkeley, Los Angeles, London: University of California Press, 1971; 66 pages including 2 plates, 28 tables, 5 text figures; paper, 26 × 16.7 cm.; $2.50.

Because of the predominance of bark beetles as destroyers of standing timber, and because of the unsuitability of chemical methods for their control, studies such as this one are of interest and importance not only to acarologists and entomologists but to everyone concerned with forest management and conservation. Kinn's adaptation of his doctoral thesis could well serve as a model for similar studies and reports on other mite-insect associations. Although in this instance the mite does not appear to be a useful adjunct in the control of the beetles, the carefully documented background survey and the meticulously controlled original investigations add much to our understanding of the complex interrelations of scolytids, nematodes, and mites of many kinds.

The mite in question, a species described by Kinn himself in 1970, lays its eggs in the tunnels of the beetles, particularly in those of *Ips confusus* (LeConte) and *I. montanus* (Eichhoff). The mites in all stages feed upon certain nematodes associated with the beetles and abundant in their galleries. Adults of both sexes are phoretic upon the emerging beetles in numbers of from one to eight per beetle. Kin has studied the sensory basis of this phoresy and has shown that the moisture content of the phloem substrate is a more important factor than temperature or atmospheric humidity both in inducing and terminating phoresy. Olfactory recognition of the hosts appears to reside in the mites' palpi and, more especially, in the tarsus of leg I. The reader, incidentally, must give close attention to the distinction between the singular "tarsus," and the plural "tarsi," to avoid being confused by some of the experimental data. In addition to the life cycle and behavior, the sex ratio, chromosome number, and incidence on various beetle species at different times of the year are informatively studied and tersely reported.

There is an excellent summary and a bibliography of 161 titles. The text figures and photographic plates are of good quality. The editing, layout, printing, paper, and binding conform to the usual high standards of the University of California Publications in Entomology. I noted only one typographical error: "Milleilungen," for Mitteilungen in the Wolff citation, page 62.

Asher E. Treat

Centurie des Lépidoptères de l'isle de Cuba. Ph.(elipe) Poey. Paris, 1832. Reprinted, 1970, with foreword and notes by C. F. Cowan, pp. I–XII + (1–4) + (53) pp., 20 col. plates. In North America obtainable from Entomological Reprint Specialists, P. O. Box 77971, Dockweiler Sta., Los Angeles, California, 90007, $30.00.

Felipe Poey y Aloy was one of the great naturalists of the 19th century whose work was fundamental to the explosive growth of our knowledge that took place in that period. Born in Havana in 1799, where he early began collecting Lepidoptera, he was largely educated in law in Spain and France. Returning to Cuba in 1832, he lived there until his death in 1891, active until the last. His publications, of which this is the first, did much to make the geology, mineralogy and zoology of Cuba known to the world. In addition he corresponded with many Europeans, to whom he sent specimens and information.

This volume is one of the very important series of reprints being issued by Classey in the field of entomology of old and rare books that are not available to the majority of workers today. These reprints may, in fact, be more useful than the originals because of modern forewords or prefaces, which explain important biographic or bibliographic matters. Again some of the colors in original copies have changed badly, and these have been reproduced in something like their original states. (Many of the old books were hand-colored, either by careless copyists or with impermanent pigments, so that surviving copies show a great deal of diversity.) Examples of other works reprinted are: The English Lepidoptera, by Moses Harris, 1775; the enormously important Exotic Microlepidoptera, by Edward Meyrick, 1912–1937; and An Illustrated Essay on the Noctuidae of North America with a Colony of Butterflies, by A. R. Grote, 1882.

ALEXANDER B. KLOTS
The American Museum of Natural History

Studies of Fossiliferous Amber Arthropods of Chiapas, Mexico. Pt. II. University of California publications in Entomology. 1971, Vol. 63, 106 p. 3 pls.

This is the second collection of papers dealing with the arthropod fauna of the Chiapas amber. Nearly half the volume consists of a paper on spiders by the late Prof. A. Petrunkevitch with other contributions on Acari, Hemiptera, Diptera, Coleoptera and Microcoryphia.

Prof. Petrunkevitch's paper deals with fourteen specimens received too late for inclusion in his 1963 account of spiders from the Chiapas amber. Before the manuscript was complete, Prof. Petrunkevitch died and the task of preparing the paper for publication fell to Harriet Frizzell, who also died before the work was finished. With such an inauspicious gestation it would perhaps be uncharitable to criticise this paper too harshly, but few arachnologists would consider the erection of new genera based on distorted exuviae, particularly when one is from an immature putative linyphiid, a significant contribution to science.

JOHN A. L. COOKE
The American Museum of Natural History

Svensk Spindelfauna. Families 1–4 (Salticidae, Thomisidae, Philodromidae, Eusparassidae. Albert Tullgren. Originally published in Stockholm, 1944. Facsimile reprint by E. W. Classey Ltd. 1970, 138 p., 18 pls. $10.80.

This is the first part of a projected monograph on the Spiders of Sweden. Although only two additional parts have actually appeared (dealing with six more families) the series has become accepted as a major contribution to North European arachnology. In particular the numerous illustrations of genitalia are of outstanding quality. Unfortunately, for reasons that are obscure, almost the entire printing of the first part of Svensk Spindelfauna was destroyed before distribution and only a very small number of review copies survive. These extremely rare volumes are doubly valuable as they deal with families not adequately covered by existing monographs.

This reprint is well produced and bound in hard covers. Although the illustrations do not equal the original in softness and clarity, they are still good and completely usable. The publisher is to be congratulated for making this work available once more to the arachnological community.

JOHN A. L. COOKE
The American Museum of Natural History

The Insects of Australia, A Textbook for Students and Research Workers. Division of Entomology, CSIRO, Canberra, Melbourne University, Press Carlton Victoria 1970, XIII & 1029 pg., 9 color plates, 881 figures U. S. sales by International Scholarly Book Services Inc., Portland Oregon $22.50.

Despite the large number of contributors, the format is written in a style which leaves the reader feeling it was written by a single author, demonstrating the discipline of the editor. The color plates and numerous illustrations with fine detail are first rate and further serve to enhance this excellent text.

The first six chapters contain a detailed summary of general entomology. The chapters include skeletal and general anatomy, physiology, cytogenetics, reproduction and metamorphosis, and general biology. The general biology is concerned with the insects' adaptations and associations needed for their existence and survival. Chapters 7–9 summarize the principles of classification and nomenclature, evolution and classification of insects, fossil history, and an often neglected area, composition and distribution of the fauna. The remaining 28 chapters review the insect orders, two of which (Zoraptera, Gryllobattodes) have yet to be recorded from Australia.

Each chapter follows the same format beginning with an introduction, anatomy of adult, immature stages, biology, life history, natural enemies, economic significance, special features of the Australian fauna, and classification including keys and examples from Australia.

The classification is modern; however, it is to be expected that other groupings might be preferred by some readers.

The text concludes with a 24 page list of references which is not considered an exhaustive bibliography by the authors. An extensive index completes this volume.

Although written primarily for students and research workers of Australia, other entomologists should find this substantial text of interest and value.

Frederick H. Miller, Jr.
Nassau County Medical Center

INDEX TO SCIENTIFIC NAMES OF ANIMALS AND PLANTS
VOLUME LXXIX

Generic names begin with capital letters. New genera, species, subspecies, and varieties are printed in italics. The index does not include aphid genera and species found in the article, "More Records of New Jersey Aphids (Homoptera: Aphididae)," by Mortimer D. Leonard, pp. 62–83.

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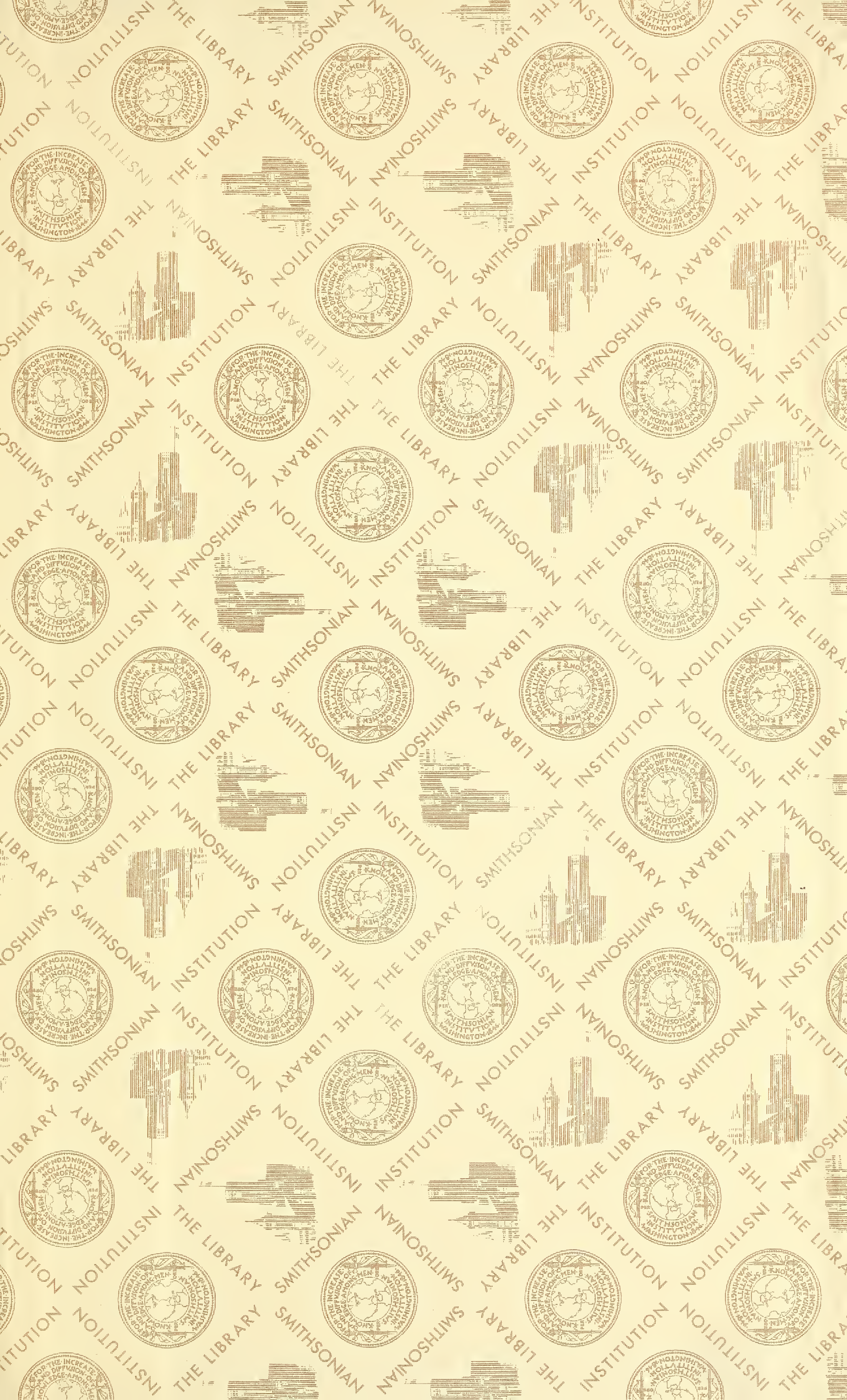
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